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A STUDY OF TRACHOMA AND ALLIED CONDITIONS IN THE PUBLIC SCHOOL CHILDREN OF NEW YORK CITY.*

BY A GROUP OF WORKERS UNDER THE DIRECTION OF ANNA WESSELS WILLIAMS.

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I. INTRODUCTION AND CRITICAL REVIEW OF LITERATURE.

ANNA WESSELS WILLIAMS.

Introduction.—Judging from the written word, our knowledge of trachoma is in a most confused state. This is partly due to the fact that, notwithstanding the voluminous bibliography on the subject no minute critical review of the whole has been made for some time, hence the relations between the older observations and the more

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recent ones are not clearly defined. For instance, tho the majority of ophthalmologists consider "Egyptian ophthalmia" a broad term including several different diseases, such as gonorrheal ophthalmia, acute contagious conjunctivitis ("pink eye"), and trachoma, some ophthalmologists still use the term as synonymous with trachoma only. Again, tho the great majority of authorities differentiate between a benign follicular conjunctivitis and a "granular trachoma," some still consider any conjunctivitis with definite follicles as a trachoma, and a few even think that folliculosis, i.e., follicles on an otherwise normal conjunctiva, is "trachoma in stage of invasion."

It is true that Boldt (1904), Axenfeld (1912), and others have given more or less detailed and clear statements of the trachoma situation as recorded in the literature and as gained from their personal experiences, but on the whole they seem to take for granted more definite knowledge than the original records show and hence their deductions appear too positive.

In looking up the literature we have been unable to find reports of consecutive observations on a large series of cases extending over a period of time long enough to include the supposed limits of the course of the longest trachoma cases. The lack of such published records is probably the chief reason why confusion still prevails in regard to several important points. Still a third and of course the most important reason for confusion lies in the fact that the specific cause of trachoma still remains to be definitely proved.

We began our studies about 4 years ago (in the spring of 1910) with these three points chiefly in view: (1) to determine how much we really know of the condition called trachoma; (2) to study the relation of trachoma to allied conditions; and (3) to search for the specific cause of trachoma. Our general plan of work was to study minutely for a long time both from a laboratory and a clinical standpoint a large series of cases embracing "trachoma" and allied conditions. Some of our earlier studies have already been reported, but these papers will give a complete description of the work continued to date.

The critical review of the literature, which is necessarily brief, is taken up under the following heads: (1) Definition, (2) History, (3) Geographical Distribution, (4) Race, Age, (5) Helping Causes, (6) Specific Cause, (7) Symptoms, (8) Treatment, (9) Summary.

1. DEFINITION.

That our knowledge of trachoma lacks exactness is shown at the outset by the different emphasis placed upon the same points in the various attempts at definition. These attempts are made partly from a clinical standpoint, partly from that of histopathology, and partly from a mixed standpoint. For example, Fuchs says (1908): "Trachoma, like acute blenorrhea, is an inflammation of the conjunctiva which originates by infection and produces an infectious purulent secretion. It is distinguished from acute blenorrhea principally by the clinical course in which is developed an hyperplasia of the conjunctiva that forms the most characteristic symptom of trachoma. From the roughness of the conjunctiva caused by this hyperplasia the disease has received its name." In this clinical definition the points emphasized are only two, an infectious purulent secretion and a chronic hyperplasia. Nothing is said about discrete follicles or, definitely, about cicatricial tissue formation. Again, Morax says: "Trachoma is an infection producing nodular lesions (the granulations) situated chiefly on the tarsal conjunctiva, but may be in the conjunctival sacs and even on the cornea. The lesions progress slowly and leave after them very often cicatrices." Here the follicles are chiefly emphasized, and it is admitted that not always is cicatricial tissue formed, and nothing is said about secretion. The Trachoma Commission of Philadelphia agree with Morax, except they state definitely that the process progresses, if unchecked, through its various stages of inflammation to destructive infiltration of the cornea, cicatricial contraction of eyelids and great interference with, if not total destruction of eyesight. Here for the first time pannus is mentioned, and the greatest emphasis is placed upon the destructive changes as a whole. Boldt is more particular and more inclusive. He says: "Trachoma is a chronic deep and dense lymphoid infiltration of the conjunctiva (and tarsus) appearing sometimes diffusely, sometimes as circumscribed masses of cells leading to the destruction of the conjunctiva and its transformation into fibrous tissue, and showing for a time at its onset an abnormal secretion upon which its contagiousness depends." Here follicles are indicated and the hyperplasia leads to destruction of the conjunctiva, that is, to cicatricial tissue formation. Clark, Schereschewsky, MacMullen and others agree essentially with Boldt. Safford sums up the definitions made chiefly from the clinical standpoint thus: "The essential clinical feature of trachoma is a hyperplastic granular destruction of the palpebral conjunctiva."

Axenfeld, giving only descriptions of various phases, does not condense into a definition.

Then come the definitions from the pathologic studies. Thus, Goldsieher says: "Trachoma is a proliferating inflammation of the vascular layer of the conjunctiva in which the perivascular cell infiltration appears in diffuse or granular form." Pascheff says: "The only true trachoma is characterized by a lymphoid tissue richly developed in germinative centers. This tissue is not specific, but is the same as granulations of the pharynx and nasopharynx and experimental follicles." These definitions contradict that of Prowazek who says that the trachomatous process begins in the epithelium of the conjunctiva. Mutermilch tries to correlate these two ideas by the following elaborate definition: "Trachoma consists in a long series of consequent and, in an anatomic and physiologic relationship, unavoidable changes which strive for the establishment of a new and lasting equilibrium between the epithelium and the subepithelial tissue, and which are started by any infectious inflammatory process. It is in no sense different from other chronic pathologic processes in mucous membranes similar to the conjunctiva. The trachoma process is a complex anatomic change which strives for conjunctival cicatricial tissue."

Mutermilch also calls attention to the obvious fact that the ophthalmologist could never diagnose trachoma in the early stages if he depended upon the definitions given, since most definitions include cicatricial tissue formation.

There is no point on which all are agreed. Therefore trachoma does not stand out clearly as an entity from a study of the definitions. Details, however, give a different aspect to the definitions in several important particulars.

2. HISTORY.

Practically all authorities are agreed that early statistics are too indefinite to be trustworthy. Without doubt several quite different diseases were included under one name. Thus Boldt states: "Egyptian ophthalmia included not only the trachoma of the present, but simple catarrh, follicular swelling, follicular conjunctivitis and blenorrhea." From the original memoirs Morax judges that the cases of Egyptian ophthalmia energetically attacking the armies of England, Belgium, Austria, and France in the beginning of the nineteenth century, and considered by many authors as granular trachoma, were for the most part acute contagious conjunctivitis. Fuchs and others make the same statement.

The association of follicular conjunctivitis with trachoma has led to still greater confusion. "Up to 1870," says Morax, "they were confounded." Then arose the dualistic and monistic theories. Later many authors insisted upon differentiating between trachoma, follicular conjunctivitis, and folliculosis, and now practically all ophthalmologists agree on this point. They differ only as to their definitions of the three conditions. Boldt states that the few supporters of the "unitarian" theory (Raehlmann, Mandelstamm, Lawrentzen, and others) who regard follicular conjunctivitis as an attenuated form of trachoma are found almost exclusively in countries where trachoma is widespread, while those who believe in the "dualistic" theory are in countries more or less exempt from trachoma. Until exact definitions are settled upon—whether they be correct or not—we shall still be unable to correlate the reports of different persons.

3. GEOGRAPHIC DISTRIBUTION.

The same criticisms may be made in regard to statistics on geographic distribution. Until we are at one in our definitions we cannot be sure of our limits of distribution. But the greatest difficulty now is, as Boldt points out, that "owing to the slow and insidious course of many of the cases with a vast number never coming under medical treatment it would require exhaustive investigations of the whole population of a district before reliable statistics could be drawn up." Until this can be done we have to rely upon relative figures and general statements which are often quite misleading.

All countries reported as hotbeds of trachoma (e.g., Egypt, Arabia, Russia, Poland, Finland, Armenia, Ireland, etc.) show also many infections with the Koch-Weeks' bacillus and the gonococcus as well as with many other germs pathogenic for the eye. Hence in these areas it is difficult to determine the specific effects of each infection. Fuchs calls attention to the fact that there are no good statistics concerning the relative frequency of these eye diseases. And we shall not have them, I repeat, until many consecutive cases have been under recorded observation made from minute cultural and clinical study throughout the entire course of each and all of these diseases.

This minute study has been done least of all in those districts where trachoma is reported as endemic. In this country, for example, in the mountains of Kentucky and on the Indian reservations, trachoma is said to be prevalent and increasing, so occasionally one investigator or a group is sent to these areas for a few weeks or months. The result is usually a report of the number of existing cases diagnosed as trachoma, but we are no nearer a knowledge of the real nature of "trachoma" than we were before. If this work could be planned so that comprehensive records started by one group of investigators could be carried on by another over the required number of years we would be in a position to settle the boundaries of at least some of the questions relating to these conjunctival infections, such as insidiousness, intermittence, chronicity, contagiousness, etc.

The Indian reservations are ideal places for keeping such records since they are under direct government control and the individual case can be easily followed. Especially favorable would be the Indian boarding-schools in which Schereschewsky reports such a high percentage of "trachoma," e.g., 90 per cent in one school in Oklahoma.

Of course, until we can show a specific cause we cannot be sure of any statistics for a disease reported to have such manifold variations. But if we have recorded descriptions of the whole course of a large number of consecutive cases we may be able more readily to detach one group of cases from another and to place each group geographically. At present the maps prepared by certain authors are necessarily inaccurate.

4. RACE AND AGE.

In general, authorities are agreed that no race is exempt. According to reports negroes are less susceptible than the other races but this may be because fewer as a whole have been examined. MacMullen says that numbers of well-marked cases in negroes from the West Indies are annually detected at Ellis Island.

All are now agreed that no age is exempt, tho this point also has been disputed.

5. HELPING CAUSES.

There is no dissenting voice from the conclusion that trachoma is a disease above others that is fostered by ignorance and filth. Hence it is found to be first a disease of families among the poor. "The family is the incubator." Cases appearing among the well-to-do are only apparent exceptions. Treacher-Collins cites an instance in point:

"In South Australia, the disease is met with in well-fed, strong, healthy farmers and their families, who reside in roomy, well-ventilated houses. South Australia is, however, a riverless country. Each individual farmer has to arrange receptacles for the storage of surface flood water, and the greatest economy in the use of this conserved water has to be exercised to make it last over the rainless summer months. Where scarcity of water exists, regular and proper ablutions amongst the inhabitants are sure to be neglected and the possibilities of the transference of contagious diseases of the eye are greatly increased. The other accompaniments of a hot, dry district which predispose the conjunctiva to infection, and which aid in the introduction of infective matter into it are also present, viz., frequent dust storms and abundance of flies."[1]

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[1] Abridged from Collins' report in the preface of his translation to Boldt's book on *Trachoma*.

According to Morax, "Cleanly Arabs have little trachoma, dirty ones have much." Very recently both MacMullen and Stucky have given detailed accounts of the unhygienic habits of the Kentucky mountains cases, and Schereschewsky, of those of the Indians.

That the disease is of a milder type today ophthalmologists say is due to the more effective carrying out of better hygienic measures everywhere. When we consider how far this still is from the ideal we need not wonder that chronic eye conditions still prevail.

Anything that lowers general vitality, such as tuberculosis, may of course aid any disease. Anything that lowers local vitality appears to be of greater importance in these eye affections. As early as 1861 Weiss considered that trachoma could occur as a sequel of old conjunctival inflammations. Boldt says: "All chronic irritating conditions of the eye, especially obstinate conjunctivitis, augment the tendency to trachoma. . . . . Individual predisposition is increased by external sources of irritation. Among these dust and smoke are of prime importance, for by long-continued action they set up chronic conjunctival irritation. Further, heat, moisture, wind, want of sleep, over-crowding and bad ventilation must be mentioned."

Since unhygienic habits and lowered general and local health also help to produce conjunctivitis from whatever cause, a study of the helping causes of trachoma does not aid in making the disease an entity.

6. SPECIAL CAUSE.

Nearly all authorities agree that trachoma is an infectious disease spread by contact, but a number of investigators doubt that a single specific organism is the cause. The conjunctival sacs are such favorable localities for the growth of several different varieties of microorganisms, especially when invaded by one variety, that the flora obtained from any one examination may be quite large. For this reason it has been easy to admit the theory of multiple causes. Cazalis, who made an extensive study of the etiology of trachoma in 1896, came to the conclusion that bacteria of the various forms of conjunctivitis can, under certain conditions aided by the patient's predisposition, produce trachoma. Later, Mutermilch, Pascheff, and others state that trachoma in no respect differs from other chronic inflammatory processes occurring in mucous membranes whose structure is related to that of the conjunctiva, such as chronic urethritis, atrophic rhinitis, chronic appendicitis, etc. They conclude that trachoma belongs to the class of typical chronic inflammations of the mucosa produced by various causes.

For this reason, too, several other research workers have made claims in favor of one out of a number of known microorganisms as the specific cause of trachoma. Thus the gonococcus, the streptococcus, Koch-Weeks' bacillus, the influenza bacillus (Muller's bacillus), and various other micrococci and bacilli, as well as yeasts, moulds, protozoa, each has had its day, only to be dropped in favor of a new organism when a new investigator happened to find a few cases in which one or the other of these microorganisms seemed to predominate. Some of these hypotheses have lingered longer than others. Some, we have with us still; for instance, the gonococcus hypothesis (Alt. Herzog), tho Morax says (1906): "It is not necessary to discuss the relation of gonorrhea to trachoma. Granulations occurring as the result of gonococcus infection are of short duration and do not cicatrize." Mutermilch on the other hand calls attention to the prevalence of gonococcus infection in the Egyptian trachoma cases and comes to the conclusion that the gonococcus must have some part in the process. At intervals new claims are brought forward in favor of the gonococcus. The latest, by Herzog, since the discovery of the "trachoma or Prowazek inclusions," is that the gonococcus may become involuted into these granular inclusions.

Claims for ultramicroscopic forms (Raehlmann, Bertarelli) have also been brought forward. Pfeiffer and Kuhnt, however, were unable to get positive results from the use of filtrates into human eyes.

In this report, we are presenting strong evidence in favor of the influence of the group of the hemoglobinophilic bacilli in chronic conjunctivitis—at least evidence that these bacilli may produce a hyperplastic inflammation which may result in cicatricial tissue formation. So we shall give more details of the bibliography of this group as related to the pathology of the conjunctiva.

The Koch-Weeks' bacillus which is placed in this group, tho most authors say it can grow without the presence of hemoglobin (this question of growth will be taken up in the original work), has been frequently reported as occurring in trachomatous eyes, from the time of Koch (1881). Thus Collins (1909) says: "In many cases of trachoma in this country (England) now the Koch-Weeks' bacillus is found in the mucopurulent discharge from the conjunctiva which occurs during an acute exacerbation of symptoms. The ophthalmia introduced by the troops from Egypt was most likely, then, not one disease, but a mixed type." Muller says: "In the majority of adults with trachoma the Koch-Weeks' bacillus was found." Markus states that the Koch-Weeks' bacillus is the cause of "Schwellungskatarrh" (our papillary conjunctivitis). Mutermilch goes further in declaring that "often repeated infection with the same microorganism, e.g., bacillus of Koch-Weeks, produces a series of exacerbations on an already inflamed conjunctiva and finally produces the picture of trachoma."

Many of the bacterial examinations have been made by smears alone, hence the identification of the bacteria was made chiefly from morphology. This means, as we have shown, that many may have been missed. Moreover, successive cultures from the beginning to the end of the disease have seldom been made, neither have hemoglobin-containing media often been employed. Indeed, seldom, if ever, has minute search been made on a large scale either for the hemoglobinophilic group of organisms or for the gonococcus in these chronic eye infections. Earlier reports were taken for granted as representing the whole truth. When we realize that the specific organism may be scanty in the later stages of a disease or that it may be difficult to isolate because more deeply seated or because of over-growth of secondary organisms we know that we cannot infer much from negative reports based on few examinations. Then, too, and this is a most important point, only a comparatively few investigators have used blood media, and none of them so far as we know, except ourselves, has used an enriching blood medium. Hence, doubtless, we are far from determining the prevalence of hemoglobinophilic bacilli in these eye infections.

Müller, who isolated hemoglobinophilic bacilli from the largest series of trachoma cases reported, recognized the importance of more than one examination. He considered his comparatively small percentage of positive cultures due chiefly to the fact that he could make *only one examination* in many of his cases. He had positive results chiefly in his "acute trachoma" cases. Müller thought at first that his bacillus was the cause of trachoma, but now, without positive proof, most authors have decided that it has nothing specifically to do with trachoma (Zur Nedden, Morax, and others). Thus Morax says: "It is not difficult to show that this bacillus has nothing to do with the production of granulations." But did he or anyone else show the effect of repeated infections with it on a case of simple follicular conjunctivitis, or on an otherwise susceptible conjunctiva, in producing hyperplasia and finally fibrous tissue? That it is thought to be identical with the influenza bacillus capable of invading secondarily a trachomatous conjunctiva and producing a superimposed influenzal conjunctivitis does not clear up its relation to "trachoma."

In fact, practically no detailed account has been made in the published reports of the number and minute character of attacks of "intercurrent" diseases throughout the course of trachoma and of their relation to the "exacerbations of trachoma." Only general statements have been made of numerous successive attacks of conjunctivitis, both leading up to trachoma and occurring throughout its course. Thus Greef says that the chief cause of conjunctivitis in Egypt is not trachoma but acute catarrh produced by the Koch-Weeks' bacillus and chronic catarrh produced by the Morax-Axenfeld bacillus. Dwyer and Meyerhof point out the difficulty of securing fresh cases of trachoma in any but infants who are apt to show at the same time both gonococcus and Koch-Weeks' bacillus infection. Tho Axenfeld and others recognize the fact that the Koch-Weeks' bacillus and the gonococcus occur frequently in eyes in Egypt and elsewhere, producing acute attacks of "trachoma," they do not show in how many of these eyes these bacilli continue to exist and to produce a subacute or chronic inflammation. Neither do they consider the result of a reinfection with new strains of either of these organisms in eyes already made sensitive to them. All they say is that they *think* that the present "mild type of trachoma" is due to the less frequent occurrence of the Koch-Weeks' bacillus and the gonococcus.

Blumberg in adopting the theory of multiple causes states that recurrent attacks of conjunctivitis diminish the resistance of the reticular connective tissue of the conjunctiva and cause a continual state of irritation which finally produces trachomatous changes. Boldt in quoting Blumberg goes on to say: "If we consider predisposition to consist in overgrowth of adenoid tissue, as Peters does, Blumberg's theory becomes very plausible, and we can readily understand how repeated chronic inflammatory conditions of the eye produce sponginess, atony, and a tendency to proliferation in the adenoid tissue."

We can clearly see from the above brief sketch that the question as to the ultimate influence of these bacteria on the eye is far from settled. We have demonstrated the continued presence of hemoglobinophilic bacilli in cases showing successively acute, subacute, and chronic inflammation of the conjunctiva and their increase in numbers during acute exacerbations. The following reports take up this question more fully.

In the meantime came the work of the *inclusionists*. The bibliography of this work has been gone over so fully both by this laboratory and by other sources that the chief points may be only touched upon here.

Halberstaedter and Prowazek (1907) described certain bodies in the conjunctival epithelial cells of cases diagnosed by them as trachoma. Greef, Claussen, and Frosch independently described similar bodies. Unfortunately they did not go into details as to the course of their cases so we do not know just where to classify these in a disease of such protean descriptions as trachoma. Halberstaedter and Prowazek simply state that the inclusions were found more frequently in fresh cases. The same indefiniteness as to clinical course is shown by most of the authors following them.

We can only gather that the bodies were found in largest numbers in "acute trachoma" or in "acute exacerbations of old trachoma."

Then came others who said that similar inclusions are found in acute conjunctivitis cases of the new-born, also in vaginitis, urethritis, and even in the normal conjunctiva.

As is usual after the report of a new finding confusion has arisen as to how many manifestations may be considered a part of the described bodies.

From the accumulation of evidence gained from the vast amount of work done by others on this subject as well as from our own work extending over three years we have come to the conclusion that there are inclusions in the conjunctival epithelial cells of certain cases of conjunctivitis, answering in the main to the descriptions of Halberstaedter and Prowazek and others, which are foreign invaders. We further believe that these foreign invaders may enter the epithelial cells of other mucous membranes of the body but that they could not enter the normal cell in appreciable numbers without producing an inflammatory reaction. Hence we believe that the bodies found in the normal conjunctiva (McKee, Addario) are simply incidental cell changes. Indeed the descriptions and plates of the above named authors show this.

We have already called attention to the similarity of the "typical inclusions" found in our cases of papillary conjunctivitis ("acute trachoma") to nests of the hemoglobinophilic bacilli. This work will be taken up more fully in the body of the report. This idea differs from that of Prowazek in regard to their nature. He has created for them a group which he calls the Clamydozoa—or mantle animals—and places it between the protozoa and the bacteria. Prowazek seems not to be aware of the limits of morphologic changes in bacteria.

Apparently we have no definite help in making trachoma an entity from the studies of its etiology.

Nor does the study of the reports on the *contagiousness* of trachoma help us. While all but a very few authors agree that trachoma is contagious they differ as to the degree and stage of contagion. Only general statements can be considered since the few specific statements are not backed up by enough clinical evidence to draw trustworthy conclusions. Thus Boldt says: "Experience teaches that infection does not readily occur but usually only after prolonged contact with the patient and common use of beds and washing utensils. Then one person after another is slowly infected, therefore we can only claim a restricted and conditional contagiousness for trachoma, not underestimating the significance of individual predisposition." So too, Axenfeld, Morax, Fuchs, Doyne, Clark, and most others believe that trachoma must be placed among the less contagious, or slowly contagious diseases. On the other hand a few authors say that it is highly contagious, e.g., Trachoma Commission of Philadelphia, etc.

All agree that "the danger of contagion is in direct proportion to the amount of secretion," for "the specific secretion may be enhanced by a superimposed infection." But the possibility that the "superimposed infection" may produce a hyperplastic or an atrophic inflammation seems to be lost sight of except by the few. It is true that Morax comes near it when he calls attention to the light cases—the subacute and chronic cases of Koch-Weeks' bacillus infection which "are considered non-important but which may give rise to more serious ones."

In these subacute and chronic cases, as we have shown, the secretion may be so slight that it may be easily overlooked, and even when found, the stained spreads from it may show no recognizable bacteria. Cultures, however, may show that bacteria are present. These bacilli with their possible change in virulence may insidiously attack another eye which may be in a condition to allow a chronic inflammation instead of an acute one.

We know too little either about the condition producing virulence in certain groups of bacteria, or about the conditions influencing susceptibility to their pathogenic action summarily to exclude them from a list of causes producing any degree of proliferative and fibrous changes in tissues.

SYMPTOMS.

Once more most statements are naïvely limited or indefinite. The disease is divided into types, severe and mild, papillary and granular, acute and chronic, etc., and these types into stages such as development, regression, cicatrization, etc. Different terms are used for apparently the same type and stage by different authors, which makes the confusion worse. The trouble is that the course claimed for this disease is so protean in its variations and as Collins points out, is "usually of such exceedingly long duration, that few observers have had the opportunity of watching cases from commencement to finish," and therefore of getting at a clinical entity if it exists. These confused ideas may be more easily seen by a consideration of the claimed symptoms.

Onset.—Some authors say the disease probably always begins acutely with secreting conjunctivitis (Collins, Reese, Schereschewsky, etc.). Others are just as emphatic in stating that it always begins insidiously with follicle formation and without visible secretion (Weeks, Trachoma Commission of Philadelphia, Stiel, MacMullen, etc.); while a small majority take the middle course and consider that tho there undoubtedly are acute secreting cases they are now few (Boldt, Morax, Fuchs, May, Harrison, etc.). But since all authors are agreed that "one rarely sees a beginning follicular or granular trachoma" and follows it to its terminal cicatrization, it can be seen that the character of onset as a whole in this disease must still remain a question.

Secretion.—While there is much doubt as to how often, if ever, trachoma begins with a secreting conjunctivitis, there is very little difference of opinion as to the presence of a "specific secretion" from time to time during the course. But how to differentiate between a "specific secretion" and that caused by a superimposed infection seems difficult. In fact, few attempt it and these most unsatisfactorily. Thus Morax says: "At a certain degree [?] of development there is always produced a slight mucopurulent secretion. When the secretion is more abundant [?], when the lids stick much [?] on waking, it is nearly always the result of superimposed infection. . . . . Probably all cases characterized by a purulent or mucopurulent secretion are mixed infections." Of course the majority of ophthalmologists say that they depend upon the microscope for differential diagnosis but this generally means one examination by smears alone, and as we have shown above, this is insufficient to rule out a number of bacteria. Stiel states: "In pure trachoma secretion of the conjunctiva is not necessary; on the contrary, secretion always means a mixed infection." Considering the prevalence of bacteria causing all grades of secreting conjunctivitis, the reported susceptibility of trachomatous eyes to mixed infections, and the prevalence of all conditions favoring such infections, it is highly improbable that anyone could demonstrate the course of any case of "pure trachoma" going on to cicatrization without secretion appearing at times throughout its course. The statements, therefore, "that secretion is not necessary" and "that only a slight secretion is specific" seem to be matters only of opinion.

Follicles.—An immense amount of study has been carried on concerning the characteristics of follicles in trachoma with the result that no definite clinical or microscopic differences between the follicles of "trachoma" and of other conditions have been demonstrated. While the majority of authors believe that there is essentially only one form of trachoma, that is, "granular trachoma," they cannot agree in differentiating trachomatous granulations from follicles found in any follicular conjunctivitis except by stating that the former are "follicles which lead to permanent injury of the eye," which opinion is of no assistance in early diagnosis.

Cicatricial tissue formation.—Here we have a difference of opinion again. Some authors state: "Always some cicatricial tissue is formed, however light the case and whatever treatment" (MacMullen, MacCallan, etc.). Others think with Boldt that "we no longer consider connective tissue formation and scarring to be an inevitable result as Saemisch once did, because it is frequently possible by early and appropriate treatment to stop the disease before the appearance of the cicatricial stage." Then it has been shown that certain known infections may produce cicatricial tissue, e.g., Morax-Axenfeld bacillus and gonococcus in the eye, influenza bacillus in the lungs, etc.

Pannus.—Here, tho there may be a question as to the limits of "specific pannus," practically all are agreed (even those who put pannus under complications and sequellae [*sic*]) that such a pannus exists but that it seems to have no relationship to the intensity of the infection as evidenced by follicle formation since it may occur at any time throughout the course; however, it is supposed to be more serious when it appears late in the disease, i.e., after the establishment of cicatricial tissue.

Diagnosis.—Considering all of the above conflicting statements in regard to symptoms, there is little wonder that when it comes to a question of early diagnosis, no one seems to be able to give any aid. How many of these early cases are followed up to determine whether, according to any of the various opinions, the diagnostician is right or wrong? Consequently, all authorities are agreed that "in the beginning the diagnosis must be held in suspense." "On one examination a certain diagnosis can only be made in old typical cases," that is, in cases having cicatricial tissue or "typical pannus" or both. This is simply saying that eyes showing such changes are trachomatous and leaving out of consideration the question as to how many different agents may cause pannus and conjunctival cicatricial tissue.

Prognoses.—These, of course, are various. Some say there may be spontaneous cures; some even claim that there are abortive cases which heal without scars; others assert that unless treatment be instituted in a very early stage trachoma is never cured; some say that with early treatment there may be complete recovery without scarring; others say that however early the treatment, there is always scarring, etc. Again we may take our choice.

TREATMENT.

Here we have another rather wide limit of choice. As far as prophylactic treatment is concerned all are agreed as to its importance, but few have carried it into full practice. Most of the little that has been done has been directed against follicles and not against acute conjunctivitis or the lighter subacute cases where no follicles may be present in the beginning. Until we so realize the importance of the relationship of acute conjunctivitis to trachoma that we shall employ aids on every side such as are shown in our reports on prophylaxis (see p. 281) we may expect tardy results, in ridding us of "trachoma."

The great majority of the treatises on treatment have to do with more or less advanced cases—with curative treatment. Trachoma is said by most authorities to be comparatively easily cured leaving cicatricial scars after at least several months of treatment under the following conditions, (1) when there are no complications, (2) when in children, or (3) when cases come early enough. All of which statements might be applied to any form of chronic conjunctivitis.

The principle of treatment in the advanced cases is that used in any chronic sluggish inflammation—stimulation. Several authors emphasize the importance of change of stimulants. On the other hand Boldt says that early slight cases or chronic torpid ones often do better under simple hygienic treatment.

Opinions differ now so widely in regard to the merits and applicability of operative treatment, i.e., expression, grattage, excision, that a study of them gives us little help in determining the entity of trachoma.

SUMMARY.

In summing up the mass of writing on trachoma we find that there is no widespread agreement as to the claimed essential points. The chief lack seems to be that there has been no critical following up of a large series of cases over a long period of time with studies directed especially to the following particulars:

1. Written records of each case from the beginning to the end of the disease.
2. Successive cultures as well as microscopic examinations made of each case using enriching media to detect those organisms that grow with difficulty, combined with inhibiting substances for organisms which might overgrow more important ones.

II. DIAGNOSIS AND COURSE OF FOUR THOUSAND CASES OF CONJUNCTIVAL AFFECTIONS INCLUDING TRACHOMA AND ALLIED CONDITIONS.

H. W. WOOTTON AND ANNA I. VON SHOLLY

ASSISTED BY

CAROLINE R. GURLEY, PERCY CRANE, ALICE KURTZ AND ELLA LIPSKY.

To the medical profession it seems hardly necessary to state that the diagnosis of trachoma, except in the cicatricial form, is an exceedingly difficult matter, the more so in view of the fact that the existence of such a pathological entity has recently been doubted. Is there or is there not a specific chronic inflammatory affection of the conjunctiva frequently accompanied by a characteristic involvement of the cornea, which begins with thickening of the adenoid layer and the localized accumulation of small round cells of various kinds, which are gradually transformed into granulations and cicatricial tissue? This question has been answered in the affirmative by most of the better known writers upon ophthalmology, and this description of the disease has been regarded as a classic. Recent investigations, while not conclusive, have tended to throw doubts upon this time-honored theory and to suggest that trachoma, far from being a disease *sui generis*, consists rather of a series of infections possibly of similar, perhaps of dissimilar character, from which, at certain stages, patients may recover spontaneously, or be cured by treatment, but which, after a certain period, result in cicatricial formation. This theory tends to explain why, altho trachoma is on all sides believed to be contagious, no specific organism of the disease has been discovered despite the most painstaking search. It also coincides with the known fact that trachoma is a disease of no special race or country but is essentially a manifestation of uncleanliness and insanitary surroundings. A person of ordinarily cleanly habits who contracts, let us say, an acute catarrhal conjunctivitis, and pays proper regard to cleanliness and treatment, is speedily cured and is not liable to immediate reinfection from his surroundings. The case is different, however, with the poor living in hovels in Eastern Prussia. Here, an attack of acute catarrhal conjunctivitis, not receiving proper treatment, would have a tendency to pass into a subacute or chronic stage, would infect other members of the family, and would, in turn, be reinfected by them. Thus the irritation caused by the original infection would tend to become more or less continuous and, unless checked by treatment and a change in hygienic and sanitary conditions, would ultimately result in the production of cicatricial tissue. This theory is as difficult to combat as it is to prove for the reason that, until someone has been able to follow closely a sufficient number of cases of conjunctival affections from their incipiency to their termination in cicatrization, and at the same time to rule out other infections which might produce fibrous tissue—a study which, so far as we know, has never been made—we shall not be able to state that trachoma as a pathological entity exists.

The studies reported in this series of papers give the results of continued observation of a large number of cases.

At the beginning of this work we established a special clinic in connection with the Research Laboratory in order to allow clinical and laboratory observation to proceed closely together.

Here we developed the folder system of records, very valuable in this kind of a study. The outer folder (see p. 275) contains the previous history of the case, the family history, notes of home visits, and the original and supplementary diagnoses of the case with the results of microscopic and cultural studies; while the inner cards, which may be added as needed, contain a minute description of the different phases in the course of the case.[1]

Even with these descriptions, it has been at times difficult for us to come to an understanding as to each one's meaning of hypertrophy, thickening, cicatricial tissue, characteristic follicles, kinds and amount of secretion, etc. For example, is the term hypertrophy used to mean true hyperplasia, that is, proliferative inflammation with the formation of cellular connective tissue, or may it also be used to mean only a more or less temporary infiltration of lymph cells? Clinically, of course, it may be impossible to decide this question until late in the course. Again, we found that a small amount of secretion gathered in the superior *cul de sac* was not recorded by some examiners; the fact of its presence is of importance in accounting for the finding of hemoglobinophilic bacilli in cultures from those chronic cases reported as having no visible secretion, and in accounting, too, for a focus of infection.

In this way more or less accurate and continuous observations, extending over a period of about 4 years, have been made of some 4,000 cases of conjunctival affections occurring for the most part in the public-school children of New York City. These observations tend to confirm the statement of Fuchs and others that in children trachoma as it is described in its entirety is a rare disease.

The affections of the conjunctiva most common in this series of cases which have, from time to time, been regarded as trachoma by various authors, may be described under five headings.

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[1] During the first half of our work all of the diagnoses and descriptions were made by the one in charge of this part of the work (Wootton), but latterly other ophthalmologists have assisted, and finally when the ophthalmia school and the school clinics were started this part of the work was definitely in charge of another of the group (von Sholly). Only doubtful cases have been referred to the director who visited the clinics from time to time. It can be readily seen how essential are full written descriptions of each case.

OUTER FOLDER (FRONT)

Name	Place of Birth	Age	Public School	Date Admission	Case Number
Celia K.					
Address	*U.S*	*9 Yrs.*	*22*	*5/27/11*	*1436*

X

DIAGNOSIS

1. **Original** (*a*) **Clinical** *5/27/11 Follicular Conjunctivitis (mild)*
(*b*) **Microscopic** + *"trachoma inclusions,"* + *hemoglobinophilic bacilli*

2. **Complications** ——

3. **Supplemental Diagnosis** *7/27/11 Papillary "trachoma" (later called papillary conjunctivitis)*

HISTORY

4. **When did eye trouble begin?** *Dec. 1910*

5. **Subjective Symptoms** (*a*) **Onset** *Ocular injection; lids stuck in mornings*
(*b*) **Now**

6. **TREATMENT** (*a*) **When?** *Dec. 1910* (*b*) **Where?** *Gouverneur Clinic* (*c*) **Nature of Treatment**

7. **OPERATIONS** (*a*) **How many?** —— (*b*) **Where Performed?** —— (*c*) **When?** ——

8. **DISCHARGED**—(*a*) **Date** *1/28/13* (*b*) **Condition** *Normal*

10. RELATIVES

X	Relationship	Name	Age	Place of Birth	Employment or School	Time in U. S.	Date of Exam.	Eye Condition	Case Number
	Father			*Austria*		*12 Yrs.*			
	Mother			"		20 "	*4/2/11*	*O.K. 6/7/11 O.K.*	
	Sisters	*Sadie*	*10*	*U.S.*	*P.S. 98*				*1165*
		Rose	*8*	"	" "		*4/1/11*	*O.K. 6/5/11 O.K. 7/26/11 O.K. 10/5/11 O.K.*	
		Lillie	6	"	" *88*		"	*O.K. 6/5/11 O.K. 7/26/11 O.K. 3/28/12 O.K.*	
		Esther	*15 mos.*	"			"	*O.K. 6/7/11 O.K. 7/26/11 O.K.*	
	Brother	*Peter*	*3*				"	*O.K. 6/7/11 O.K.*	
	Gr'dfather						*6/7/11*	*O.K.*	

11. **No. of Boarders** *o* (*a*) **Nationality** (*b*) **How long in U.S.?**

12. **HYGIENIC SURROUNDINGS** (*a*) **No. of Rooms** *3* (*b*) **Other Occupants of Sleeping Room Adult** *o* **Children** *1* (*c*) **Does Patient Sleep in Separate Bed?** *No*
(*d*) **If not, with whom? Child** *V* **Adult** (*e*) **Separate Towels?** *No* (*f*) **Separate Pillow Cases?** *No* (*g*) **CLEANLINESS** *No*

OUTER FOLDER (BACK)

INSTRUCTIONS

When further comment on point is desired put "X" in column marked "X" against the point, and enter number in column marked "X" on Supplementary page.

Write first—date of interview, name of person interviewed (giving initials) and address.

Paragraph freely.

Do Not Write in This Space		X	SUPPLEMENTARY NOTES
Home Visits	*4/1/11*		*See front of sheet.*
	5/27/11		*December last, eyes red and stuck in mornings; went with sister to clinic; not told nature of trouble; mother says no trouble now; never was kept out of school; mother says redness lasted only a day or so.*
	6/5/11		Celia. *Tarsal conjunct. practically normal except for few fine folls.; lymphatic dilatations lower lids.* Lillie *O.K.*
	6/7/11		Sadie. *Tarsal conjunct. normal color, vessels seen, moderate number translucent folls. on tarsus and in canthi. Lymphatic dilatations lower lids. Follic. Conj.*
	7/26/11		Celia. *Conjunct. upper lids very much thickened; papillary condition; vessels not seen; mucopurulent secr.; lymph. dilatations of lowers. Looks like "Trachoma." (Goes to Gouverneur Clinic three times a week.)* Sadie. *Tarsal conjunct. somewhat thickened, with numerous folls.; vessels obscured; slight secretion; ptosis right eye.* *Mother very shiftless and indifferent.*
	9/25/11		Celia. *At Convalescent Home at Wilton, Conn.*
	10/10/11		" " " " " " " *; has gained 4 lbs.*
	2/24/12		Celia. *Eyes still paste in morning.*
	3/28/12		*Mother preparing for holidays. Walls just painted, but everything else extremely untidy and dirty. Mother seems rather suspicious or indifferent, certainly not interested in regard to instructions; says too busy to attend demonstrations now. Eyes O.K. (but condition favorable for re-infection).* Celia *and* Sadie *now go regularly to housekeeping classes at 226 Henry Street.*

FOLLICULOSIS.

This is a pronounced type of follicular formation without evidences of inflammation. The writers would describe follicles clinically in this group of cases as situated either upon the surface of the conjunctiva or in its substance. They may be situated on any part of the conjunctiva of both lids but everywhere arise from a normal base. The underlying conjunctiva is not thickened and its blood vessels are perfectly distinct. In the upper, and more especially in the lower, fold of transition, hemispherical or ellipsoidal, yellowish translucent bodies may also be discernible. These are less firm than the follicles and are simply an accompaniment of the follicular affection and may be or may not be present. They are also sometimes observed upon the ocular conjunctiva, and are said to be simply dilated lymphatics. There is no secretion and the eyes are not injected. There are no clinical symptoms even when follicles are present in a marked degree. This form of conjunctival affection in itself never terminates in cicatrization and is never accompanied by corneal involvement. That these cases, uncomplicated, are harmless is shown plainly by the course of our series of cases, given in Table 1. Only three of these cases were operated upon, and only two showed, about one year after first seen, a conjunctivitis during which pannus developed. All of the others—over 2,000 cases—have now either normal conjunctivas, or only a few small scattered follicles.

FOLLICULAR CONJUNCTIVITIS.

In this variety, follicles are present as before and the "lymphatic dilatations" may or may not coexist. The mucosa, however, is injected, secretion, for the most part watery, is present, and the eyes appear suffused. Mucous or mucopurulent secretion may also be present from time to time. There is no thickening of the conjunctiva surrounding or underlying the follicles. These cases would, according to the theory above described which denies the existence of trachoma *per se*, be capable, unless cut short by treatment, of becoming hyperplastic and terminating in cicatrization. One occasionally, tho rarely, sees in children cases presenting at the same time the follicular formations, secretion, and pannus.

TABLE 1.

CHIEF CLINICAL POINTS IN COURSE OF 4,261 CASES UNDER OBSERVATION.

ORIGINAL DIAGNOSES	LATER DIAGNOSES	NUMBER	FOLLICLES	PANNUS	CICATRICIAL TISSUE	OPERATIONS		PRESENT CONDITION				NUMBER LOST SIGHT OF
						Before Seen	After Seen	Unimproved	Improved	Cured		
										Number	Average Time	
Old trachoma	Old trachoma	59	48	32	59	25*	3	10	36	4	3 yrs.	9
Acute, hypertrophic, or papillary trachoma	Papillary conjunctivitis	181	162	8	58†	64	6	8	19	136	9 mos.	18
Doubtful trachoma	Papillary conjunctivitis	161	161	3	49†	58	9	6	15	123	10 mos.	17
	Follicular conjunctivitis	20	20	0	5†	7	0	0	0	19	1 yr.	1
Follicular conjunctivitis	Papillary conjunctivitis	16	16	1	3†	4	2	2	6	7	1 yr.	1
	Follicular conjunctivitis	665	665	0	45†	51	3	0	69	596‡	1 yr.	(?)‡
Acute catarrhal conjunctivitis	Papillary conjunctivitis	20	8	2	2†	3	1	1	4	15	6 mos.	0
	Acute catarrhal conjunctivitis	700	105§	0	0	0	0	0	0	700‡	6 wks.	(?)‡
Folliculosis	Papillary conjunctivitis	5	5	2	2†	3	0	0	2	3	6 mos.	0
	Folliculosis	2,120	2,120	0	0	0	0	0	0	2,120¶	1 yr.¶	(?)‡
Miscellaneous	Blepharitis, phlyctenular conjunctivitis, etc.	300	190	0	0	0	0	0	0	294	3 mos.	(?)‡

* It was often impossible to get clear histories from these old cases. Probably all have had at least one operation for expression.

† Only operative scars presumably.

‡ These cases were not all examined at the present time. The great majority, at least, are still in our schools and are sent to our clinics from time to time for examination, and immediately, if inflammatory symptoms supervene.

§ Mild folliculosis, chiefly, after acute process had subsided.

¶ With the exception of mild folliculosis in a comparatively small number of cases.

This fact, according to the point of view, may be held to support either the theory in question or the theory that there is such a pathological entity as trachoma.

In most of those cases which, according to our observations, have presented conjunctival thickening (hyperplasia?) as well as follicular formation, the follicles have been larger than in the cases we are prone to call follicular conjunctivitis. In some adult cases which one of us (Wootton) has seen, the presence of follicular formation deep in the conjunctiva itself has been evidenced by the occurrence here and there of small yellowish infiltrates. Such cases the observer called trachoma, since pannus had been seen to occur in several of them. No case clearly of this type has been seen in the series of school children here studied. Out of the 671 cases diagnosed when first seen as follicular conjunctivitis, 16 developed later a subacute papillary condition all of which, except one, cleared up without showing pannus.

PAPILLARY CONJUNCTIVITIS.

The characteristic feature is thickening of the conjunctiva, presumably through infiltration with lymph cells and wandering connective tissue cells. Follicles may or may not be visible and when present do not form an essential feature of the disease. The conjunctiva is thickened and red; its blood vessels are invisible or obscured; mucopurulent secretion in varying degree is always present tho sometimes in so small an amount that only an occasional flake can be seen in the superior *cul de sac*. In these cases the so-called trachoma inclusions or bodies of Halberstaedter and Prowazek are so frequently present that they may be regarded as a constant feature. For this reason, in the early part of the studies upon which this article is founded, these cases were regarded as trachoma.

In following the course of these cases, we found that practically all of them recovered after presenting a subacute or chronic condition for a varying number of months, *without having developed either pannus or cicatrization.* All of these cases were treated, most of them from the beginning, both at home and in the clinic in our usual way (p. 281), hence we cannot be sure what course all of them might have followed without such treatment. All we can say is that our observations lead us to support the suggestion of Cohen and Noguchi that "trachoma inclusions" are microorganisms which may produce a conjunctival affection having nothing to do with classic trachoma. From the work of Williams and others of our group (p. 329), it would seem that the "trachoma inclusions" in this type of cases are nests of hemoglobinophilic bacilli growing in the epithelial cells of the conjunctiva. This latter hypothesis supports the observations of Markus and others who have stated that members of the group of hemoglobinophilic bacilli are the cause of papillary conjunctivitis (*Schwellungskatarrh*).

TRACHOMA.

These are the cases which present the well-known characteristics of cicatricial degeneration or corneal involvement or both. In our table we have classed all of those that showed these characteristics when first examined by us as "old trachoma," excepting 8 cases of papillary conjunctivitis with pannus which gave a history of moderately short course. The few cases of cicatricial tissue formation which appeared during our 4-year period of observation were post-operative cases and the scar tissue apparently was a result of operation. These and the pannus cases are indicated in the "course" columns of Table 1. From the study of the group of cases classed as "old trachoma" in our table, we can infer little, since we were not able to study them from the beginning. But from those proceeding to cicatricial tissue formation (without operation) and pannus while under our observation we may hope to gain more light.

In favor of the classical theory that trachoma is a disease *per se*, we must not lose sight of the peculiar character of the corneal involvement which so often occurs when the conjunctiva shows cicatricial changes. This keratitis, designated by the special name "pannus," is described as an infiltration of small cells between the superficial epithelium and Bowman's membrane, which proceeds from above and is accompanied by vascularization from the adjacent conjunctiva. It may gradually invade and destroy Bowman's membrane. In our series of cases we have found a condition answering to this description in 48 cases. In 16 there is an acute history and as yet no cicatricial formation has been observed in any of them. Eight of these 16 cases developed the pannus while under our observation, and the other eight showed beginning pannus on first visit and gave a history of a moderately acute process. The other 32 cases were all old cases when first seen by us. The microscopic findings in these cases are given on p. 315.

Let us now turn for a moment to the consideration of the corresponding conjunctival affections of adults. The pure follicular type (folliculosis) is exceedingly rare, but when it does occur is no more liable to disagreeable sequelae than in children. The second type, follicular conjunctivitis in a pronounced form without thickening of the conjunctiva, is, we should say, practically unknown in persons over 16 years of age. Papillary conjunctivitis is found in adults and presents the same characteristics as in children.

The terminal stage of trachoma, represented by cicatrization of the conjunctiva and pannus, is much more common in adults than in children. Most of the cases in New York City occur among the foreign population probably as the result of infection in foreign lands. These cases are decidedly less frequent in our clinics at present than they were 10 years ago, and there can be no question that this desirable state of affairs has been in part due to the strict enforcement by the immigration authorities of regulations prohibiting the entrance of trachoma into this country, and in part due to the stricter carrying out of rules of personal hygiene in schools and homes, and the greater care of eyes in the clinics. The terminal stage of trachoma is, however, still seen in adults who have lived in the city all their lives and who, so far as can be judged from the history, have contracted the disease during adult life. We naturally ask ourselves what characteristics these cases presented in their incipiency and previous to the stage of cicatrization. The immigration authorities, judging from such of their cases examined by us, regard thickening of the conjunctiva, especially that of the retrotarsal fold, as the most characteristic symptom of incipient trachoma. The detection of slight thickening in this location, however, is sometimes a difficult question and a matter of personal opinion, and for this reason doubtful cases are isolated and observed for a period of some weeks before the final diagnosis is made.

In our series of cases a number that have shown clinically deep-seated follicles and a thickened retrotarsal fold have apparently recovered without a trace of cicatricial tissue in evidence.

SUMMARY.

1. Several processes in the conjunctiva of children, evidenced clinically by a more or less chronic thickening or follicle formation or both and formerly considered as a part of a chronic process called trachoma, may run a comparatively quick course to cure without the formation of cicatricial tissue.
2. Trachoma as it is described in its entirety is very infrequent at present in the public-school children of New York City.

III. PROPHYLACTIC TREATMENT OF TRACHOMA AND ALLIED CONDITIONS IN THE NEW YORK CITY SCHOOL CHILDREN.

1. SPECIAL OPHTHALMIA CLASSES, SCHOOL CLINICS, SUMMER CAMPS.

ANNA I. VON SHOLLY
ASSISTED BY
CAROLINE R. GURLEY, ALICE KURTZ, ELLA LIPSKY,
MARY SCHMIDLING, AND THEODORA HERZIG.

SPECIAL OPHTHALMIA CLASSES.

Practical measures on a large scale for the prevention of trachoma and other infectious eye diseases date from the beginning of the nineteenth century. They were first promulgated by the military authorities as rules of hygiene for the army in order to keep in control the more or less severe epidemics of ophthalmias that played havoc with the troops. Since soldiers are recruited from and discharged back into the civil population, the next logical step was to extend the supervision of the state to the latter.

With the increased knowledge of etiology and prophylaxis of infectious diseases, measures more or less efficient are being taken in all advanced countries to ward off epidemics, not only of trachoma, but of all infections in public and in charitable institutions where numbers of people are collected together. Thus, in the twentieth century all nations that stand at the front have certain regulations for the inspection and care of their public-school children. It is obvious that through the army and the public schools the state and municipality have the easiest and most direct control over a large proportion of the population. Each unit is in more or less close relationship with several units of the rest of the population through the family and neighbors.

The details of the method of control for the suppression and extermination of eye infections in the various countries, as well as their immigration regulations, are fairly well known and can be obtained from the attached bibliography. It is enough to say that as the result of the measures used trachoma is seen only sporadically in urban centers and not frequently seen in the country districts except in certain foci mentioned by Dr. Williams where the economic and hygienic conditions are of a very low grade. Large epidemics, such as were known before the early nineteenth century, do not occur. Small epidemics occur in an occasional institution or town, but are quickly curbed. However, so long as these foci exist and migration continues to grow easier we cannot afford to relax our guard.

Dr. Williams has given the various theories of the etiology of trachoma. Whichever be correct, it is agreed that contagion is carried through the medium of the conjunctival secretion. Moreover, the logical deduction from our theory as formulated by Dr. Williams makes it incumbent on us to give much more consideration than hitherto to our methods of handling the acute and subacute conjunctival inflammations.

The general rules governing the prophylaxis of infectious eye diseases are those of segregation of the affected during the secreting stage and the enforcement of personal and domestic hygiene. Recommendations for bodily cleanliness, especially of hands and fingers, clean personal habits, individual bathing utensils (sponges, washcloths, towels), the use of individual bed clothes, pillowslips, sheets, etc., are found in every book and article written on the prevention of these diseases and some of our methods of enforcing these recommendations are given in the succeeding paper.

The particular contribution which we have made in the prophylaxis of trachoma is in the establishment of special day classes in the public schools of New York City for children suffering from any form of conjunctival infection. Thus these children may be kept under control, segregated, treated, and taught prophylactic hygiene.

The method of handling infectious eye diseases in all the cities of this country and Europe, where attention is paid to the matter at all, is to exclude all children showing conjunctival secretion and simply to advise treatment. A certain number of cities have an inspecting nurse or doctor teach the child and its family the methods of transmitting infection. When the actively secreting stages pass, the child is readmitted to school and if not completely cured is told to continue under treatment. Of course this means that a number of subacute and chronic cases with secretion too small in amount to be easily detected may continue to be a menace to others.

In 1870 in England, Mr. George Critchett, finding a large number of eye infections in one of the schools, advised the establishment of "a ward or separate school" where these cases might be isolated, treated, and still receive their education. In 1873, such a school was tried for a year with most satisfactory results. Not much was done after this on a large and more formal scale until 1888, when an isolation school for 400 children was opened at Hanwell. The surgeon in the school reported a decrease in ophthalmia from 35 per cent in 1889, to 7 per cent in 1893 and 0.5 per cent in 1895. Later, as the result of the success of the school, provision was made to take care of the children of the poor-law schools who were suffering from ophthalmia, and two isolation schools were erected in 1903 and 1904 at Swanley and Brentwood, respectively, where the affected children are still being isolated, treated, and educated. These, however, are resident schools.

In New York City there are more than 700,000 public-school children. The 1912 Health Department report showed that 33,860 of these children had suffered from acute contagious conjunctivitis during that year, and 15,245 from so-called trachoma ("granular lids," which included folliculosis and follicular conjunctivitis). The larger part of the sufferers live in the poorest and the most congested parts of the city. Their surroundings and habits are such that each one is a focus of contagion to his neighbors.

Our school children have been under periodic and careful examination for eye diseases by the Health Department since 1902 and all children considered a source of danger to others have been excluded from school until certified cured by a physician. As far as her authority has carried her, the school nurse has forced every child diagnosed as suffering from trachoma, follicular conjunctivitis, blepharitis, acute conjunctivitis, keratitis, etc., under medical care either of the family doctor or a public dispensary. To obviate any financial hardship, the Health Department established free eye clinics in the congested districts. The children not excluded but under treatment are obliged to show the nurse at intervals a signed note from a doctor or a dispensary card stamped with date of treatment to prove that they were under medical care. The excluded children have been supposed to report daily in the school nurse's office to show the progress of their case. As far as possible home visits for the purpose of instruction have been made by the nurse.

The weakness of the above system of handling eye diseases among the school children—the prevailing system of all the large cities in this country and Europe—is that neither the Health Department nor the Education Department has full control over the children, and the valuable opportunity to concentrate on education in hygiene is not fully utilized. The exclusion of the infected child from school does not cover the situation. The feeble quarantine which it entails does little else but call attention in a mild way to the contagiousness of the disease and the need for treatment. The necessity for rapid cure in order to limit the period that the child is a carrier of infection and the teaching and enforcement during this period of personal and domestic hygiene are neglected.

The problem in New York City is not an easy one. There is a large foreign population, poor, ignorant, unclean in their habits, many parents willing and glad to use the excuse of "sore eyes" to have the child remain at home to help in the family work. The children are self-willed and indulged, and when they refuse treatment are not forced by their over-ridden or deceived parents to submit.

Children suffering from folliculosis (up to the past year called "trachoma" by the school doctors) have been permitted to attend school regularly provided they showed proof of being under a doctor's care. Between these children and the school nurse there has been a constant conflict. The child and the child's parents cannot understand enforced treatment where there are no, or so few, subjective symptoms. The child evades the unpleasant and irksome treatment, deceives the nurse, some even going so far as to buy date stamps and stamp their own dispensary cards. Where a particularly rebellious child has refused treatment absolutely, the nurse has had to choose between allowing the child to have his will, thus undermining her authority and that of the school, or exerting her power to exclude the child from school until he submitted—the very object the child frequently wished.

In the case of the excluded children, with their exclusion they pass out of the jurisdiction of the school and the nurse too. Only the actively infectious cases are usually excluded. These children may roam the streets at will, carry infection to all who come in close contact with them (as they frequently do in their play), for the 14 to 16 waking hours instead of the 8 to 10 hours otherwise spent out of school. These children do not necessarily place themselves under treatment; many are glad not to go to school. Girls take advantage of the plea of "sore eyes" to remain at home to help in the housework and are even encouraged by their parents. Boys have been started by exclusion from school on the way to become incorrigible truants. They acquire the street habit.

On the other hand there is the financial hardship to the family when a child approaching 14 years of age is excluded from school and kept from getting his working papers through lack of required school attendance.

After a year's study of the problem, the workers at the Research Laboratory, co-operating with the Division of Child Hygiene, agreed that the exclusion principle was inadequate. They suggested to the educational authorities that experimental classes for children suffering from infectious eye diseases which ordinarily exclude them from school be opened in one of the most infected parts of the city. In October, 1912, two classes in close connection with a Health Department eye clinic were started in the lower east side at Hester and Allen streets as an annex to Public School 65. One wing of a vacated school building was fitted out by the Department of Education. On the ground floor is the playground, one flight up, two clinic rooms and a demonstration room, and above these, two classrooms and a washroom. The classrooms each seat from 15 to 17 children. The washroom contains a porcelain wash basin with a gooseneck faucet worked by a foot lever, so that the child touches no part with its hands. All washing is done with running water. There is also a bubbling drinking fountain of porcelain worked by a foot lever.

Three days a week a Health Department clinic is held in this building. All children with eye disease from some 60 adjoining public and parochial schools are either sent or brought in squads for treatment by the school nurse. The children who formerly would have been excluded are transferred without delay to the infectious-eye disease classes. The principals of their respective schools are notified by printed post card.

The mild cases of folliculosis are instructed to use boric acid drops at home and are placed under the school nurse's observation. If these cases become marked or show secretion, they are referred back to the clinic. The marked cases of folliculosis are treated at the clinic one or more times a week, chiefly with bichlorid of mercury rubbings. Other cases, such as blepharitis, keratitis, etc., needing treatment report to the clinic as heretofore. The children are given cards with the diagnosis stamped on them for the information of the school nurse who has typed instructions as to what course to pursue.

The children retained in the special classes are treated according to prescribed directions of the clinic doctor twice a day, by the special nurse assigned to duty at the ophthalmia school. Medication formerly left to the child's discretion for use at home is thus given in the school. Now we know that the child receives this treatment. If the child absents himself from school, the truant officer is sent for him.

In addition to actually taking care of the eyes, the nurse in attendance teaches the children personal, family, and social hygiene by talks, demonstrations, and quizzes (see p. 301). In the demonstration room (furnished in simple fashion as a sanitary bedroom), demonstrations on domestic hygiene and the care of the eyes are given to the mothers. The children are taught the value of cleanliness. They are obliged to keep their hands and nails clean, and are taught not to rub their eyes with their hands or wipe them with their coat sleeves or caps. Their hands and persons are inspected daily, and as a reward for cleanliness honor buttons are given them. At the end of the term, the child who has the best marks for cleanliness receives a small manicure set. At the end of the school day, each child washes his own desk and chair with soap and water. This is done chiefly for its educational value.

This school is unique among New York City schools in the matter of cleanliness. The clinic room, the corridors, and stairs are mopped up daily. The waiting-room and schoolrooms are wet-swept daily and scrubbed three times a week. The toilets, banisters, and side walls as high as the tallest child can reach are wiped down daily with a disinfectant. The chairs and desks in the classroom are wiped down with a disinfectant after the children have washed them with soap and water.

All possible precautions are taken to avoid carrying infection from patient to patient. A basin of antiseptic solution is on either side of the doctor so that the hands covered by rubber gloves can easily be disinfected between patients. This is done whether there is visible secretion or not. Medicine droppers are not allowed to touch patients' eyelids, and are always dipped in an antiseptic solution before they are returned to the bottles. Bluestone pencils are not used from one patient directly to another, but are immersed in 95 per cent alcohol for a time before being used again. Pledgets of cotton wrung out of boric acid solution, one for each eye, are given each child to catch the excess of medication and secretion. These are thrown into an enameled pail and burned later.

The nurse visits the homes of the children in attendance and gives instruction to the mothers in their own homes. Printed leaflets in three languages, Italian, Yiddish, and English, giving instructions on the care of the eyes are distributed to every new patient in the clinic (see p. 298).

Two teachers are in charge of the ophthalmia school. The children, ranging from 7 to 16 years of age, are divided into two classes of mixed grades, one of the older and one of the younger children. The children's eyes are protected from strain as far as possible. All work, as far as it can be, is oral, and all reading and writing of very short duration or omitted in severe cases. Regular routine grade work is not made the object of the class. Since the majority of the children spend a comparatively short time in these classes, more stress is laid upon hygiene and the care of their health than on the "three R's." Such work as is given is rather for the purpose of keeping their minds and hands occupied. The school session is shortened, the morning session beginning at 9:15 A.M. and the afternoon session ending at 2:15 P.M., with one hour from 12 to 1 for lunch. One half-hour in both morning and afternoon is devoted to recreation—play in the neighboring park in fair weather, story telling in bad weather. Last year's schedule was as follows:

9:15 to 9:30.	Assembly
9:30 to 10:00.	Treatment and Rest
10:00 to 10:30.	Arithmetic
10:30 to 10:45.	Spelling
10:45 to 11:15.	Recreation
11:15 to 11:45.	English
11:45 to 11:55.	Reading
11:55 to 12:00.	Wash hands and Dismiss
12:00 to 1:00.	Lunch
1:00 to 1:15.	Wash hands and Rest
1:15 to 1:45.	Recreation
1:45 to 2:15.	Hygiene (Monday), Geography (Tuesday, Wednesday, Thursday, Friday).
2:15.	Dismissal to Clinic for Treatment.

Up to June 20, 1912 (9 school months), 312 pupils had passed through the ophthalmia school. The various kinds of cases treated were as follows: acute conjunctivitis (including acute contagious conjunctivitis or "pink eye" and phlyctenular conjunctivitis), chronic conjunctivitis, trachoma, follicular conjunctivitis, syphilitic, tubercular, and phlyctenular keratitis, and neglected protracted cases of blepharitis. When school closed June 28 there were about 25 children in the classes, with 17 ready for discharge. Only three during the year had been returned to the class after discharge with a recurrence of the disease. The shortest stay in the class was 2 days, the longest, the entire 9 months. Among the latter there were 8 children with post-operative and cicatricial trachoma and pannus or ulcers.

From the health point of view the disease is attacked early, prevented from becoming chronic, and is kept under persistent treatment so that the cure is shortened, while at the same time both children and parents are taught how to avoid reinfection and spreading the disease to others.

We have made the recommendation that the Health Department request the Department of Education to establish one or two more of these special classes in co-operation with a Health Department clinic in the congested districts farther uptown. We feel that with an intelligent nurse especially trained in eye work to oversee the school, there would be no danger of infection to other children if such a class or classes were held in a regular school building. The reason for the belief is based upon the experience with the clinic of Public School 21.

SCHOOL CLINICS.

While we were negotiating with the Department of Education for the formation of the special ophthalmia classes, an opportunity to open an infectious eye disease clinic in Public School 21 was offered. This school is in the congested Italian district somewhat remote from the Health Department infectious-eye disease clinic then located at Gouverneur Slip. As an experiment, this clinic was opened during January, 1912, in a room set aside on the second floor in the school building. We have no special infectious eye-disease class in this building—there is no unoccupied room at present that can be used for this purpose. Clinics are held twice a week during the morning school hours, to which not only the children of Public School 21 come, but also children from the neighboring public and parochial schools. An exceedingly competent nurse was placed in charge to carry out the prescribed treatments twice a day, as in the ophthalmia school at Hester and Allen streets. Children with acute conjunctivitis, phlyctenular conjunctivitis, follicular conjunctivitis, papillary conjunctivitis, in fact all children with conjunctival secretion who in Public School 65 clinic would be placed in the special class, either are excluded temporarily with instructions to report to this school clinic twice a day for treatment or, if secretion is slight, are placed in their regular classroom at a desk somewhat apart from the other children. Directions for avoiding the conveyance of the disease are given to the child and to the teacher. The chair and the desk which the child occupies are washed with antiseptic solution after school and the banisters leading to the clinic room are washed daily with an antiseptic after each clinic is held. Through the exceptional personality and co-operation of the principal of the school, Mr. John Doty, and of the nurse in charge, Miss Schmidling, we have had absolutely no difficulty in keeping the children under control. The excluded cases, which are becoming fewer and fewer in number, report faithfully to the clinic twice a day. The nurse in charge gives instructions to the children in personal and general hygiene, visits the homes and instructs the mothers. In spite of the fact that the school takes care of about 2,500 children and is not kept any cleaner than the average public school in New York City (with the exception of the clinic room which is mopped up daily), we have had very few acute cases during the past two years. We have never traced an infection carried from one child to another in the classroom.

While we do not strongly recommend the clinic in the school alone without the classes for the excluded, it cannot be denied that it works very satisfactorily in this particular school. Without, however, the co-operation of a principal who has a strong personal hold on his pupils and without a thoroughly competent nurse who has a personality that attracts children without loss of dignity or discipline, such a clinic might not be a success. To this clinic the mothers and fathers of the school children, the older and younger brothers and sisters, friends and neighbors, are brought for treatment by the pupils. By treating them and allowing them to come twice a day if necessary, we have gained a strong hold in the neighborhood.

SUMMER CAMPS.

Since trachoma is one of the infections which bar children from admission to the fresh-air homes and camps, and since no special provision is made for them, they have no opportunity for a change of environment and food except a rare trip to Coney Island with the family or a visit to a "country relative" in Hoboken or the Bronx. In excluding children from the summer-vacation homes, the broadest interpretation is given to the term trachoma. No child with follicles, whether the eyes be in a secreting condition or not, is admitted. The justice of excluding these cases of folliculosis, now considered benign and non-communicable, is to be questioned. Of course children with conjunctival secretion should be excluded. As I have said above, the children affected come from the poorest homes and the most congested parts of the city; most of them do not receive sufficient or proper food at home.

For a month in the summer of 1911, through the generosity of the A.I.C.P., we were able to send selected children from our clinic to a home set apart for them at Wilton, Connecticut. The result was most satisfactory. A nurse and a helper were with the children so that their treatment was carried out daily. Following this demonstration, it was hoped the Health Department would construct a permanent summer camp for trachoma and infectious eye diseases, but funds were not obtainable and the matter is in abeyance.

In the summer of 1913 the *New York Globe* made an appeal to its readers and through their generosity enough money was collected to send 29 children to a farm at Cuddebackville, Orange County, New York, for the whole 10 weeks of vacation. The isolated location and the sanitary arrangement of the farm were well adapted to the demands of such a summer home. A Health Department nurse and a volunteer helper were with the children all summer and the routine treatment was carried on twice a day as in the special classes in New York. The doctor visited them at intervals. The children were out in the open air all day long, and bathed daily in the river. Each child had certain duties, such as making her or his own bed, helping in tidying up the room, and washing his or her own clothes. The children were housed in three dormitories, each in an individual bed, with individual bags holding the clothes, at the foot of the bed, and, of course, individual soap and towels. They washed in the running water of a small runlet in the open air. Cleanliness of the person and general behavior were marked daily on a bulletin posted in the hall and had a splendid effect in keeping up the eagerness to excel. All of these cases were chronic and had been under observation for a long time. Of the children who spent all 10 weeks there, none gained less than 5 pounds in weight and a few gained as much as 10 pounds. Those who were there a shorter time gained from 3 to 6 pounds each. As far as the eye conditions were concerned, while in several cases the improvement was marked, in the majority we did not find any more noteworthy improvement than occurred in the city under similar constant daily treatment. We feel, however, that the summer work is important and worth while and ought to be made permanent for these reasons:

1. During the summer vacation, there is no one to urge the child to undergo treatment. He neglects himself and what has been gained from the winter's treatment is lost in the summer. Some of these children who were in the country have been under our observation for more than 3 years: their condition before they came to us was chronic and has remained so. Each fall they return to school with a relapse.
2. The knowledge that faithful attendance at the clinic will mean a vacation in the country in the summer is a strong incentive to keeping under constant treatment. Since they are barred elsewhere this is their only chance to get to the country.
3. While miraculous improvement does not accompany the sojourn in the country, the improvement of their general health, the better opportunity for the teaching of personal hygiene while in residence and the prevention of relapses play an important (tho not brilliant) part in the program of prophylaxis.
4. Furthermore, neglected and running the streets of the city, these children are nuclei of infection.

Since the institution of the special ophthalmia classes, school clinic and summer camp, there has been without doubt a distinct improvement of the eye conditions in the lower east side of New York City. The large majority of patients now treated at the clinic since the opening of the second year of the special school (1913) are those of folliculosis, blepharitis (which is either on the increase or else more care in picking out the cases is taken by the school nurse), and pediculi of the eyelashes. This latter condition certainly seems to be increasing, especially in one limited section of the lower East Side.

The fresh, acute cases are seen early, are segregated, and usually run a short course. Only an occasional freshly developed case of papillary conjunctivitis has been seen since the above measures have been instituted, while between 1910 and 1912, 320 cases of papillary conjunctivitis were treated by us. The folliculosis cases seem milder; none has been sent to the hospital for infectious eye diseases for the operation of expression since October, 1912.

2. PERSONAL HYGIENE AND "FOLLOW-UP" WORK.

ALICE KURTZ
ASSISTED BY
ELLA LIPSKY, MARY SCHMIDLING, AND THEODORA HERZIG.

Early in the work of the Research Laboratory group on the preventative treatment of trachoma, home visits to patients attending our clinics were begun with several objects in view: (1) to examine and record the eye condition of other members of the family in order to determine the degree of home infectivity and to advise treatment; (2) to secure a more complete history than clinic conditions permitted; (3) to investigate the environment for the purpose of determining helping causes; (4) to give instructions, both verbally and by demonstration, for the prevention of the spread of infection, and (5) to follow up the work to be sure that the instructions were being carried out.

I. INVESTIGATION.

The first question investigated was that of infectivity in the series of cases here presented. This is considered under two heads, Helping Causes and Home Infectivity.

HELPING CAUSES.

At the outset inquiry was always made as to what was regarded by the family as probable source. Public baths, street playing, particularly ball playing, the schools, public and parochial, injuries, the visiting of relatives in Europe having trachoma, and also the eye clinics themselves were frequently given as the source of sore eyes. Many children complained of never having had sore eyes until some time after being sent to the clinics by the school nurse. Other suggested sources were "catching cold," a children's school in the country, libraries, school books and desks, and banisters in houses where there had been an epidemic.

Out of 117 families marked for general cleanliness only 4 are marked double plus, which shows that even minimum health standards in the home are not an easy matter, and only 35 are marked plus, indicating cleanliness moderately good.

Of course the question arises: Is it necessary to depend upon evolution here for results? We feel that this may be answered emphatically in the negative because of the hopeful results in habit-formation obtained by us in our ophthalmia school.

While in community or family work discouragement is nearly always present, the work with the children in the special school is encouraging for the friend with patience and perseverance who forgets iron-clad discipline—so called—and wins the confidence and friendship of the child.

Improper nourishment.—Among the most serious hindrances to good physical condition in these children is unwholesome food. Almost every child in every family gets at least one penny a day because he cries or kicks for it. Many, of course, get more. Many parents are literally afraid to refuse pennies and continue to dole them out even when the child has no appetite, rarely eats breakfast, and runs to the candy store as soon as he is out of bed in the morning. One small boy of six, still covered with day-before dirt, was seen at the breakfast table with sister and mother coaxing him to take an appetizer of whiskey to aid in the swallowing of a piece of fried fish, some coffee and bread. Nothing of this breakfast was eaten, but it was freely fingered. The visitor was told that he never had an appetite altho he ate a large amount of candy. Coffee and rolls for breakfast are almost universal from the baby of two to the grandmother who looks 80 but is nearer 50. Lunch is frequently a "snatch" meal of a piece of dry bread or bread and butter or often something bought at a push cart. Some effort on the part of teachers and visitors is made to substitute the buying of fruit for sweet stuffs. Some mothers prepare a lunch for the school children. The cleanest homes and the best foods are in orthodox families or the families with the highest ethical standards. The evening meal is the one substantial meal of the day and is usually chicken or other meat, with vegetables boiled in the soup pot. Lack of proper nourishment, and an abnormal amount of sweet stuff were found almost everywhere.

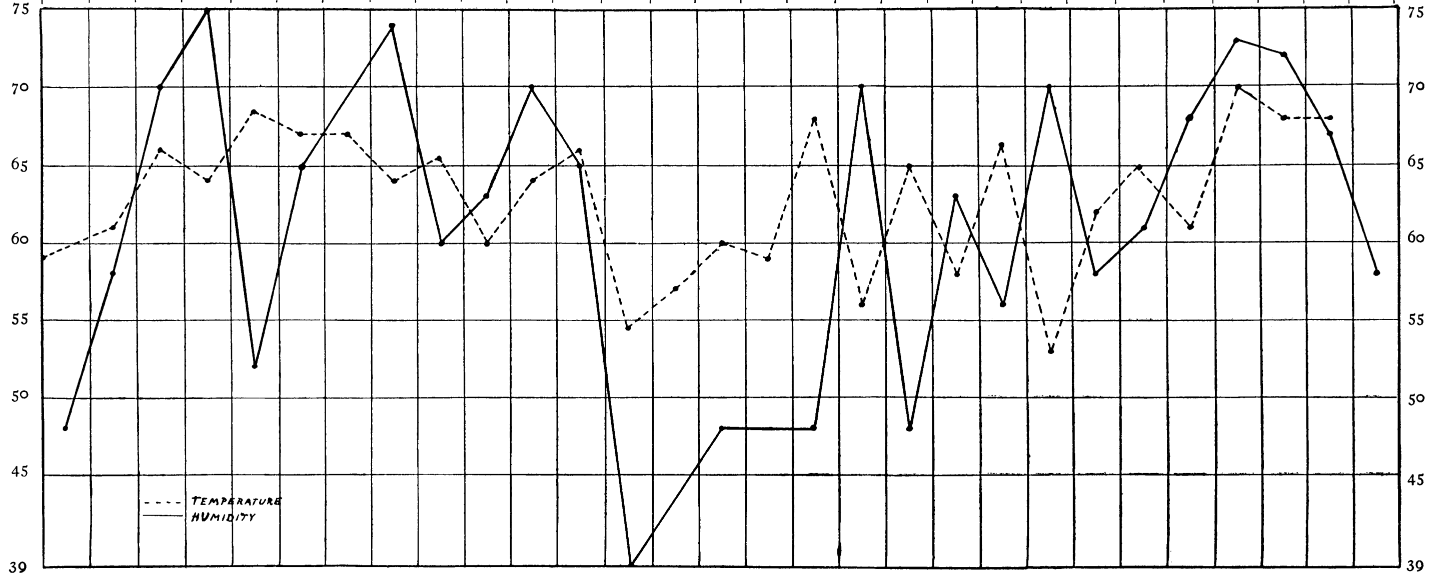
Overcrowding.—Of 116 families, on the basis of allowing 8 persons to 5 rooms or 5 persons to 3 rooms, the number of families overcrowded was 67 and on the basis of allowing 1 person to 1 room (including kitchen) the number overcrowded was 111. Of the 5 families not overcrowded, only one family had more rooms than individuals, 3 persons to 5 rooms. Only 2 families out of 116 enjoyed the same number of rooms as there were individuals in the family. The other two least crowded households had, respectively, 8 persons to 6 rooms and 8 to 7 rooms.

Upon recommending a separate bed for one small boy, the visitor was informed that it could be managed. A few days later the boy came to the visitor and said he was not going to sleep that way any more, he did not like it; that he was afraid of rolling off. The separate bed had been made on the top of an upright piano! Owing to the noise and general disturbance in one family of 11 living in 4 rooms, the older son had to put off his home study until after eleven o'clock at night. Owing to the overcrowding of the rooms, to the noise, light, and disturbance on the part of their elders, the children do not manage to get to sleep much before ten and frequently are kept up later.

Light.—The measurements of light, temperature, and humidity were undertaken under instructions from Professor Winslow, of Columbia University, who has decided that the results shown in the light experiments are suggestive of wrong method, and so they are left out of his report. The method used, however, showed at least the wide variations as, for example, the difference between 46.5 in a dark kitchen, and 81 at the front window on the first floor of the same apartment. An attempt was made to measure the light in the most used room of each of the 50 families visited. In this study no definite connection between dark rooms and trachoma has been shown.

Temperature.—The temperatures shown on Chart 1, taken in December and January, indicate that there is not much overheating. In 41 families no temperature was lower than 53° F. Between 53° and 55° F. there were 3 families; between 56° and 60° F., 12; between 61° and 65° F., 12; and between 65° and 70° F., 14. There was no case over 70° F. Thus, out of 41 families, 33 had 66° F. or under, 15 had 60° F. or under, and 3 had 55° F. or under. However, may not the desirability of some of these low temperatures be questioned, especially when noted in connection with poor food, or little of it, ill health, and insufficient clothing? Of course, in respect

No. of family	1	2	3	4	5	6	7	8	6	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Number in room	3	4	2	2–4	6	4		7			2–6	6	4	4	7	7	2	6	3	5	8	4		2	2	3	9		5
Heat or cooking-steam	None	None	None	C	R	R					R							R C						R C		R C			R C
Kind of room	S	K	K	K	K	K	D R	K	K	K	K	K	K	D R	D R	K	K	K	K	K	K	K	K	K	K	K	K	K	K



S = sitting-room; K = kitchen; D R = dining-room; R = range; C = cooking.

CHART I.—Showing range of temperature and humidity in 29 families.

to both temperature and light it is largely only the mother and babies who would really suffer, as most of the others in the family are at home a comparatively short time, except when in bed.

Humidity.—The range of temperature and humidity in 29 homes may readily be seen on Chart 1. The drop from air temperature, or difference between wet and dry thermometers, was measured by means of the Sling psychrometer and the actual humidity was obtained from the relative humidity table of Queen and Company, Philadelphia.

Toilets.—Out of 158 families only 13 had toilets in their own apartment. According to law there must be one toilet to every two families. On nearly all floors there are 4 families and 2 toilets. Many of our patients have 8–13 in one family, 2 water closets for 32–52 people! Taking the average number in the families as 7, it means that in one house, on one floor of 4 families and 2 toilets, there are 14 men, women, and children to one toilet; that is, in the whole house of 6 floors there are 170 persons using the 12 water closets in this *one* house 365 days of the year, going through narrow, dirty, and dark halls, stumbling over stairs, filthy and dark, and over stray cats and children. This is only in *one* house. This one house is massed up against another so much like it that the laws in regard to light and air are followed barely in the letter and not at all in the modern human spirit. One of the consequences of this overcrowding is that the children run frequently to the street for urination. Naturally the necessary washing after the use of the toilet is seldom if ever carried out. In the home apartment there is water—frequently only cold—in the kitchen only, and beside the kitchen sink hangs the family towel. The use of individual towels and washcloths and much soap and water is almost nil. Most of these people have not been taught the importance of personal hygiene. The sanitary requirements of the city are for the most part carried out except perhaps in regard to care in avoiding odors. Stale odors and others were marked in many cases in the halls and toilets. With the exception of a few houses—one in markedly bad condition—the toilets were fairly clean, at least superficially. The space occupied is very limited.

Employment.—The largest number of fathers seem to be employed in sewing or pressing clothing or in selling. Of 60 families, 21 of the mothers act either as janitress or help at selling in store or at stand, while but 2 do home work—aside from housewife's work. When sometimes the workers of the family, including mother and father, leave as early as 5 o'clock in the morning and the care of the children is left to the oldest child, it may be considered as little short of marvelous that the mother, or one of the older daughters, creates a semblance of order and cleanliness once a week, out of most chaotic and filthy conditions. Everywhere an effort is made to have a clean house on the Sabbath.

Income.—Altho somewhat eager to note the income of these families it was found to be impossible in the time at our disposal or without special investigations looking to that end. While the questions of income and rent were put with as much tact as possible, much keener ingenuity was displayed in avoiding the answer. The means of existence ranged from none at all—where the workers were on strike, or where the principal occupation was "looking for a job," or because of sickness or seasonal occupation—to bank accounts of fair size. These latter were not acknowledged but inferred, and in one case proved, where the mother, who needed expert care quickly and had been sent to a hospital by the visitor, was refused as a suitable charity case by the city Department of Charities. It was found through letters from a bank that this family had an account of at least $2,000, while anonymous warnings placed the savings at from $8,000 to $10,000.

Summary.—From the foregoing it will be seen that the chief causes regarded as contributory to the spread of chronic conjunctival affections are the crowded and unwholesome conditions of tenement-house life, which involve contact of normal children with those infected, and which lower the general physical condition and resistance of the child. These conditions are based upon insufficient income, inertia, and ignorance. Parents frequently bear too heavy burdens in the care of a large family of young children during strikes, dull times, and "off" seasons in seasonal occupations. The cases of deliberate indifference and neglect on the part of the parents are few.

HOME INFECTIVITY.

As our school clinics were in but two districts the children belonged, with comparatively few exceptions, to two races, the large majority being Jews and most of the others, Italians. Out of 174 cases the number of children known to have been born abroad was about 40. The two series of studies on infectivity, one by C. R. Gurley (p. 285) and the present one, contained a majority of families common to both, but a small number peculiar to each. The estimate of infectivity was, however, made upon a somewhat different basis in the two cases. For each series were selected families in which at least one member had trachoma and in which were at least several other individuals accessible to infection. In the first series only those members of the family were counted as infected from the trachoma individual whose cases were diagnosed as trachoma. In the estimate which follows, however, cases diagnosed as doubtfully trachoma as well as those of trachoma (papillary conjunctivitis with follicles), were counted as originating from the individual having the condition called trachoma.

Tables were made including 64 families representing an aggregate of 577 persons. Of these families with an average of 9 individuals each, 27 had home infection very probably and 2 had home infection probably. In the 27 households showing home infection, there were 211 individuals, of whom 68 were infected (see Table 2). Calculating upon the basis of one member in each family having been infected from outside, we have 41 out of 184, as the number of home infections, or 22 per cent.

The 27 families in which home infection occurred had an average population of nearly 8, yet the average space to a family was 3⅓ rooms, or about 2⅓ persons per room.

While the percentage of home infectivity resulting in cases diagnosed as trachoma seems to be low, the infectivity of certain cases of acute conjunctivitis in the home and among playmates has probably a very high percentage. Thus in a family of 8 all had "pink eye" with the exception of the two older sisters who slept together. No one knew how the infection was caught, but it was found that the baby of two years had sore eyes first. This child had been playing with another child in the house who had had "sore eyes," but who was now well. The boarder and all except the two older daughters of the family used one towel. These two daughters slept together and used one towel in common, but kept it in their bedroom.

TABLE 2.

SHOWING PROBABLE HOME INFECTION.

NUMBER OF FAMILY	INDIVIDUALS IN FAMILY	NUMBER INFECTED	
		Adults	Children
1	8	1	4
2	8		2
3	9		1 1(?)
4	11		4
5	8		2
6	5		2
7	11		1 1(?)
8	7		2
9	6		3
10	8		4
11	9		3
12	7	1	1
13	7		3
14	7	1	2
15	4		2
	115	3	38
16	8		1 1(?)
17	9		1 1(?)
18	6		3
19	7		3
20	11		2
21	6		1 1(?)
22	5		3
23	8		1 1(?)
24	9		2
25	8		1 1 (Conj.)
26	10		2
27	9		1 1(?)
	96		27

Total number of individuals exposed to infection, 184 (211 minus 1 in each family regarded as source).

Total number of individuals infected, 41 (68—27) or 22 per cent.

TEACHING.

In teaching, emphasis has been placed (1) upon immediate and follow-up instruction of the individual child and members of the family in all cases of secretion, and (2) upon preventive work with other members of family.

In the winter of 1910–11 in the clinic in the Research Laboratory, each child on entering the clinic was observed by one of Dr. Williams' assistants and careful instruction given. Owing to the large number that soon came to the clinic, it was found impossible to give individual instruction and group instruction was supplied to those who came one-half hour to one hour before clinic. A hygiene club was formed and minute instructions given; the members promised to come to clinic with, and to keep, clean hands, neck, ears, and noses, and to ask for the use at home of separate pillow, separate towel, separate soap, to wash under running water if possible, and in general to carry out the details of the home instructions given them.

HOME VISITING.

In home visiting, in order to avoid implications of carrying infection from family to family, it was important that the nurse-visitor should not touch with unprotected hands the sore eyes of the child. Rubber gloves were worn and the hands were dipped in an antiseptic solution immediately before touching the lids. Thus sterile gloves or cotton wet in boric acid solution alone touch the lids.

To get results, unless much more time could be given in the individual home, the demonstrations in cleansing the eyes in the home were discontinued except in cases demanding immediate attention and in which the mother could not come to clinic or demonstration rooms.

As a consequence home visiting excluded demonstration of cleansing of eyes in the home, except in rare cases, and included gaining friendly relations with mother or both parents. The history of "sore eyes" in family and neighborhood was obtained; methods of utilizing home material and space for carrying out the suggestions given at clinic were demonstrated. Mothers were invited to the special demonstration room. Prevention and control of infection in the home were taught with constant emphasis upon cleanliness and the infectivity of secreting eyes. All members of infected families were kept under observation.

That this work of preventive teaching may accomplish wonders is illustrated by the case of a center of infection in Broome Street. One child, sent to the clinic by the school teacher, had not appeared at the clinic. On notification, the special nurse went to the house and interested the mother in bringing her child to the eye clinic. No other children in the family had an eye infection, but there were several cases of sore eyes in the neighborhood. Six children were then called upon, all of whom named one child as having the first sore eyes in the neighborhood. This boy, who had been a case at our own clinic, was now well, but there were 7 cases from this particular playmate source. The playmate source of infection, whether at home, at school, or on the street, seems to be one that needs special attention.

A great deal of effort has been expended in striving for some control over family habits, the majority of homes visited possessing a family towel. Suggestions as to the necessity of separate towels, face cloths, soap, burning of eye cotton, faithful cleansing of hands and eyes, were met with a ready acquiescence—seldom fulfilled—or with a hopeless shrug of tired shoulders. In some few families, a special effort was needed to help the families themselves in finding separate towels. Fairly good towels would be pulled forth from a weird collection of rags and a nail was found somewhere and hammered into the desired spot. One or two of the families, however, after the whole family had become infected, had learned certain details of care by bitter experience, and so realized the importance of our efforts to instruct them. Thus Mrs. ——— asked why all this effort and teaching of mothers and children had come so late. "Why," said she, "did you not try to do this seven years ago, when we first had sore eyes? I myself, many a day, have sat on one of those benches and told mothers to take care of their children's eyes. I am no bacteriologist, I cannot even write my own name, but seven years ago, I thought the mothers ought to have been taught and ought to have had the leaflets you are giving today."

In spite of the usual inertia, the word "catching" was in nearly all cases an open sesame to interest and friendliness. The difficulty of changing the attitude or actions of some of the families may, however, be observed in the case of Harry K. For two years this family was visited frequently, the mother attended demonstration classes, yet Harry became worse. Even coming to the clinic several times a week did him no permanent good. He was sent to the hospital until the secretion, which constantly poured from his eyes, was taken care of. On improvement he was returned home, but was soon again in the same old state. This was a simple case of home neglect and mental or perhaps physical inertia. His mother, who had been almost constantly ill, was sent to a hospital and after a sojourn of several weeks she came home, moved into lighter rooms, and in general took more interest in the life of her family. But the real change became apparent when this child was made to come to the special school regularly. He was treated two or three times a day or as often as the doctor thought necessary. He was made to become as clean as was possible at the school. His nose, eyes, and fingers were under constant supervision. His mother actually co-operated when she became stronger, by insisting upon his attendance at school without the help of the truant officer. She also kept him in fairly clean blouses, something that had been unknown before. It is believed that she even made him take his medicine at home. Harry was always dull, stupid, and obstinate, his physical handicaps making him more or less lifeless. Since he had been out of school for months and as he could scarcely see, he sat in the backyard most of the time playing with the baby. The life in the school, however, and the daily walks to the park with other children soon changed him into a much livelier boy.

CLINIC INSTRUCTIONS IN PREVENTION OF INFECTION.

Such a simple operation as washing the nails and arms has to be taught time after time in minutest detail and with never-ending patience. Much attention was paid to cleanliness of nails, without aid of brush or other nail apparatus, getting the soap—preferably "green" soap—well into nails and using a finger nail of the other hand as a cleaner. Talks at the same time were given on the purpose of the nails, and on drain pipes and the special need of, and particular pleasure in, having the individual soap and towel. Altho washing the hands before meals is a religious and health law with the majority of our patients, the methods in use leave much to be desired, as the family towel mutely but eloquently shows.

[The English "Home Instruction" leaflet, printed in three languages.]

DEPARTMENT OF HEALTH.
The City of New York.

Home Instructions Regarding Care of "Sore Eyes."

GENERAL.

Before attempting to cleanse the eyes, wash hands and finger-nails, using warm water, and plenty of soap, particularly in nails.

Wash hands as thoroughly **after** touching the eyes.

Wash under running water if possible, but if basin is used, scrub basin with soap (or soap powder), hot water, and brush before and after using.

Have separate towels for each person in family.

Have separate washcloths for each person in family.

Have separate pillow-cases for each person in family.

Have separate handkerchiefs for each person in family.

Those with sore eyes should not sleep in same bed with others in family.

After using, pillow-cases should be aired, in sun if possible, and then covered or kept from contact with other pillow-cases.

After using, towels should be aired, in sun if possible, and so hung that they do not touch one another.

All towels, handkerchiefs, pillow-cases, washcloths, used by person with sore eyes should be changed, washed, and boiled as often as possible, but at least twice each week.

It is important to keep child's nose clean by blowing nose at least twice a day regularly, morning and night.

To clean nose, apply some vaseline in nostrils, on cotton wadding wound about a toothpick or burned match.

Have windows opened at night. Give simple food to eat. See that bowels move daily.

Keep child's fingers and finger-nails clean.

TO WASH EYES.

First wash hands as directed above.

Have boric acid water and clean absorbent cotton (from drug store) or clean (that is, boiled) soft, old white rags.

Use one piece of cotton at a time, and on one eye only; wipe away secretion (matter) carefully from eye, and eye-lashes; burn cotton at once.

Wash eyes every hour, or oftener if necessary, while child is excluded from school.

As long as child is under treatment at dispensary, eyes should be washed at least five (5) times each day.

TO PREPARE BORIC ACID WATER.

Buy boric acid powder. Add one (1) heaping teaspoonful of boric acid powder to one (1) cupful of hot water. Boil in covered pan. Put in clean bottle when cool. Shake thoroughly. When cool, sediment, if any, will sink to bottom of bottle. Do not shake again. USE WHEN COLD.

TO USE MEDICINE.

First wash hands as directed above.
Then wash eyes as directed above.
Have clean medicine dropper.
Have piece of moist cotton to catch overflow, do not use handkerchief.
Have child's face upturned and eyes opened.
Drop medicine in corner of eye, nearest nose.
Have child close lids and roll eyeball.
Wash away overflow with moist cotton, do not use handkerchief.
Burn cotton at once.
Wash hands and finger-nails again.
Clean medicine dropper.

TO CLEAN MEDICINE DROPPER.

Remove rubber top. Boil for about one (1) minute, both glass and rubber parts in water containing washing soda. Rinse in clear water when cool.

Keep all eye utensils clean and dry, and free from dust.

FREE CLINICS FOR CONTAGIOUS EYE DISEASES

Department of Health

580 East 169th Street, Bronx.
341 Pleasant Avenue, Manhattan.
P.S. 21, Prince and Mott Streets, Manhattan.
P.S. 65B Annex, 78 Hester Street, Manhattan.
330 Throop Avenue, Brooklyn, N.Y.
124 Lawrence Street, Brooklyn, N.Y.
1249 Herkimer Street, Brooklyn, N.Y.

In some contradistinction to the difficulties found in certain families the real helpfulness and interest shown in many families may be mentioned. In each of the four, out of 117, families showing unusual cleanliness at each visit, separate towels were already in use and separate beds in two. A high degree of intelligence with bodily health also existed here.

MENTAL ATTITUDE.

Rating the mental attitude exhibited by parents is rather difficult but an attempt was made to show with plus and minus marks the attitude and personal responsibility of the parents. In the chart kept of these points the percentage of indifference is remarkably low, only four cases on the part of the mothers showing inertia or indifference. Considering the extraordinary difficulties under which the majority of these mothers labor, together with their physical ailments, the personal responsibility and interest shown is very high. Of these 51, the fact that 13 or about 25.5 per cent showed marked initiative is very encouraging for future home work. Under receptivity, the majority are marked fair.

Of the three difficulties, overcrowding, too much work (including illness), and poverty, overcrowding stands out as the most positive, aided largely by a general lack of order.

DEMONSTRATIONS AND MOTHERS' CLASSES.

Owing to the difficulties of teaching asepsis in the home and the ineffectiveness of attempts by the mother to follow verbal instruction, it seemed important to establish a demonstration or teaching center for the mothers and children.

With the most active and cordial co-operation of Miss Kittredge, founder of the Association of Practical House-Keeping Centers, more thorough teaching work was started at two of the model flats of the Association, one on Henry Street in the Jewish district, and the other in the Italian quarter. Because of lack of time, the work in the Italian quarter was later discontinued but the model flat on Henry Street was in use until the old school at Hester and Allen streets was fitted up for special class and clinic work. In this latter building a demonstration room is now provided. The demonstration room contains 2 beds, spread as if ready for use, a table, several chairs, and a washstand with basin, pitcher, and soapdish, surrounded by a folding screen. All the furniture is white-enameled and the basin and pitcher are of white enamel-ware (unbreakable). On screw-hooks in the framework of the screen hang the separate washcloth and towel for each member of the supposed family. By means of a long, horizontal strip of tape attached to the washable material with which the screen is covered, the comb and toothbrush of each individual are provided with a place, as in a rack, near the washstand.

During the winter of 1911 the mothers and their infected children were invited to the model flat where the kitchen and sitting-room were used for the purpose of demonstration. The advantages of having a kitchen much the same as the kitchens in the district were evident when it came to disposing of cotton that had touched the eye and when the arrangement and care of basins and other utensils, soap, and individual towels were considered. In the cold weather hot cocoa and biscuits were served in the model dining-room to our mothers and children.

In the demonstration room or model flat the actual "Home Instructions" (p. 298) were carried out. Demonstrations were given in the care of hands and nails, washing of eyes, method of dropping in medicine, care of utensils, handkerchiefs, towels, and pillow cases, burning of eye-cotton, making of boric acid solution, etc. The most compact arrangement for having separate beds and the best method of caring for a number of separate towels in a small space were shown in the sitting-room. To these were added, at the special class, simple experiments, and talks and quizzes in preventive hygiene, with practical work by the young members of the classes. The demonstrations showed just what is possible in the home. The "trachoma nurse" then visited the family, after detailed instructions had been given to the children and mothers, to see that separate towels were used.

SPECIAL CLASS INSTRUCTIONS.

Upon the establishment, through the co-operation of the Board of Education and the Health Department, of a special school of two classes and an affiliated clinic for children excluded from the regular school on account of contagious eye diseases (see p. 288), the work of instruction in hygiene was transferred to it.[1]

In connection with the "special class" or ophthalmia school are given demonstrations and talks on prevention of contagion and on personal hygiene. Every child who enters the clinic except in "rush hours" is persuaded thoroughly to clean his hands and nails while a little lecture is given on the connection between diseases, especially his eye trouble, and dirty hands and towels. Occasionally one or two have an "afraid from it," but the combination of a little tale about microbes, a little ball of green soap just for himself, with a separate paper towel, and a comparison between his own black nails and the white ones shown him, usually wins over even the most obstinate. In the clinics, also, is shown to child and parent or visiting relative, the proper methods of using medication and how to avoid touching the eyes with the fingers.

As a single example of what may be accomplished through the special class may be mentioned the case of a boy who showed little or no result after a year and a half of effort on the part of the visitor to the home, but quite marvelous improvement after a few months of the constant supervision afforded by the school.

In connection with the classrooms of the school the washroom is the center for individual instructions in reasons for coming to the class, how to take care of the apparatus shown—the washbasin and drinking fountain have pedal attachments—how to wash hands and nails, and what to do at home in order to help himself and to prevent others from getting the disease. The necessity of appearing at school every morning with clean hands, neck, and ears, and just how and when to wash eyes and face, are emphasized.

With certain cases attending the special class, special intensive work was done. It is interesting to note that of 51 children who received individual instruction, more home visiting than could be done upon patients as a whole, and clinic demonstrations, all but 6, or 88 per cent, are marked on the hygiene chart as showing positive effort on the part of the children to put into daily practice the instruction received in class and home. The six are marked fair; no one is marked as failing.

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[1] The great difficulties were largely overcome by the faithful watchfulness on the part of the teachers, Miss Mansion and Mrs. Smith, under the direction of Mr. Bulkley, principal of Public School 65. Without their interested and sympathetic co-operation, the efforts at habit formation would have been largely unavailing. It was necessary to counteract many lifelong tendencies by patient reiteration of the desired substitutes.

The Committee on Prevention of Blindness, of the Russell Sage Foundation, has very kindly lent us large educational screens depicting the dire results of the family towel and other causes of trachoma. The study of these screens is part of the education of each little pupil-patient. One screen, an awful example of the roller towel, causes shivers when the new patient is asked if he thinks that is the proper thing to use against his face. It seems so easy to agree that this towel is a carrier of disease—or rather that it might become so if in use—just as the screen says, but it is so hard to see the blackness of the home article.

The teaching of general cleanliness was also impressed upon the children through the care of their desks. Each was given a piece of cheesecloth and a basin. With these and copious water and a "ball" of green soap, every afternoon before leaving, each desk was washed. The cloth and the basin were kept clean by the child who was intrusted with them. This work did not affect the routine of school cleaning by the school helpers, however, which included the washing with carbolic solution, at regular intervals, of the desks and all parts of the school touched by the children's fingers.

Half-hour talks on hygiene were given twice a week to the senior class. These talks included some reference to the anatomy of the normal eye and very slight reference to the general anatomy. Only drawings and prints were shown. Practical talks were given and practical results were expected along hygiene lines. Outlines for the daily care of the body were required to be written out, and quizzes, many and searching, were a real delight to the nurse-teacher as mental results seemed to come with much promptitude and ease, whereas physical results were at times discouraging. Finger-print impressions were taken on agar-agar and showed many brilliant results in growths of vari-colored bacteria and moulds. The interest of the children in workable hygiene in this school seems to point the way to wonderful possibilities. The same amount of time was given to the little ones and they showed just as much interest in the agar experiments, and were desperately serious in the tale of the stove that "went out" because it had too much food thrown in and could not get rid of the waste, and in the comparison with the stove that could do so much for people when it had a good fire burning in it. They were familiar with stoves. The effective screens of the Committee on the Prevention of Blindness were used here too.

Honor-roll.—To each of those who carried out the teachings in cleanliness for a month, keeping day by day up to a certain standard, was given, with due ceremony, an enameled button on which was printed "Clean Hands, Clean Habits, Clean Homes." Besides this, all children were daily marked for cleanliness.

On passing in review the many hindrances to a healthful and improving home life for our patients, several suggestions present themselves. Instead of shorter school hours why not longer school hours—not at a desk, but longer hours under the control of the school, spent in play in the open air, in rest, in domestic science and manual training? In connection with their instruction on the prevention of infection, both boys and girls could be taught how to wash and boil clothes properly, and the necessity of so doing. The boys were always interested in the possibility of making a screen such as the one used in the "model" demonstration flat and the arrangements necessary for keeping individual towels. Such interests might be utilized in their manual-training work. Some of the children now come to school at any hour from 7:30 A.M. on, only too glad to get away from an unwholesome atmosphere of 9 persons in 3 rooms or 11 persons in 4 rooms. Perhaps with this lengthening of the hours spent under intelligent supervision will come legislation advancing the age limit at which a child may leave school. He leaves school now at the most unstable period of life.

The opportunities of teaching clean habits and other health habits have been mentioned. In this respect a decided advantage might be gained could other visitors to the home, especially the ethical teacher and Hebrew reader, be enlisted to co-operate in giving the never-ending reminders.

The lunch hour could prove a splendid source for suggestive teaching. In most schools and homes it is now a time of trial for all concerned.

Is it necessary for all the children to have tuberculosis before the open-air school comes into general use? Probably all of these children under observation in our clinics are anemic or at least subnormal.

CONCLUSIONS.

The burden of the large reduction in the number of bad contagious eye cases should be laid to several factors, the most prominent being probably the different methods followed in the eye clinics. The factor regarded as next in importance is the marked development of "follow-up" work in connection with the clinics, including special attention to "first time" acute cases.

The follow-up work should include at least the following aspects:

1. Teaching, in the home of every infectious case, of the ways of avoiding the spread of infection, and of how to control the condition in the member affected.
2. Securing, through home visits and through demonstrations and talks in connection with the clinics or the special class, of more hygienic habits of life.

CO-OPERATION.

Throughout the work we have received much cordial co-operation from many who have been interested in its progress.

Dr. R. T. Wilson, superintendent of Health Department hospitals, gave us valuable advice and material assistance in the arrangement and furnishings of our clinics and demonstration room.

Mr. Sparre, of the Brevoort Mission House, and Miss Kerr, of the Department of Health, have taken much pains in arranging for summer outings for our children; while Mrs. M. M. Marre and Mrs. Weil aided financially in sending some of the children for summer vacations.

A friend of the clinic arranged for a splendid Santa Claus celebration in our Christmas season.

Mr. John Doty, principal of Public School 21, who suggested the value of the school clinic, helped in many other ways. We also owe a great deal to him and to Mr. Kidd and Mr. Bulkley, of Public School 65, for their active aid, as we do to Miss Mansion and Mrs. Smith.

To Professor Agide Pirazzini, of the Bible Teachers Training School, we owe the translation of the Home Instructions into Italian, and correction of the proofs. Miss Mishulow, of the Laboratory, very kindly undertook the translation into Jewish, while through the overtures of Mr. Frank, superintendent of Beth Israel Hospital, the Jewish translation was typewritten and printers' proofs corrected.

To Miss Kittredge our thanks are due for the use of unusually favorable demonstration rooms; while it is impossible to enumerate all that we owe to the Committee on Prevention of Blindness.

Mrs. Weil interested a group of young Jewish girls in supplying the "Honor Roll" buttons, which were given to those who made an effort for "Clean Hands, Clean Homes, Clean Habits."

Miss Sharp, of the Beth Israel Hospital, took a personal interest in those members of our patients' families who were referred to the hospital or to its Social Service Department. Mr. Frank, superintendent of the same hospital, aided in many ways.

Many philanthropic and social agencies cordially co-operated in the care of our families; for example, the New York Department of Charities and Corrections, the A.I.C.P., the United Hebrew Charities, and the Beth Israel Hospital.

The Educational Alliance, the College Settlement on Eldridge Street, and the Clark Neighborhood House were interested in getting in touch with the boys and girls, through classes and clubs and motion pictures.

Where destitution or some particular need, such as milk or eye-glasses, was found or suspected, the United Hebrew Charities or other relief agency or interested hospital was notified and cheerfully responded. It may be added here that where Big Brothers or Big Sisters were thought to be part of the treatment of any member of the family, the Educational Alliance, the University Settlement, and other Neighborhood Houses promised their aid. The one important difficulty here was the over-demand for help along this line.

In one instance the Committee for Prevention of Cruelty to Children most kindly sent a visitor to give aid and counsel to a mother distracted by her oldest boy's midnight habits. The Educational Alliance sent tickets to their "moving pictures" in order to get some of our difficult boys interested in going to the Educational Center.

IV. CURATIVE TREATMENT INCLUDING VACCINE TREATMENT OF INFECTIOUS EYE DISEASES.

H. W. WOOTTON AND ANNA I. VON SHOLLY

ASSISTED BY

CAROLINE R. GURLEY, OLGA POVITSKY, AND PERCY CRANE.

In regard to our curative treatment of trachoma and its allied conditions or of those affections of the conjunctiva which are characterized by the formation of follicles or by hyperplasia or by both, and which, by their continuance or exacerbations, may be considered as likely to eventuate in cicatrization and involvement of the cornea, we may state that, in general, the mechanical and surgical methods and the drugs employed have been those described in every textbook. The only new treatment tried by us is that of vaccines in certain selected cases which will be discussed later.

We wish, however, to emphasize particularly the following points in our handling of the series of cases described in the previous paper (p. 295): (1) the large number of cases which were treated from or near the beginning of the disease; (2) the frequent change of treatment in the subacute and chronic cases; (3) the absence of drugs and surgical treatment in a large percentage of cases formerly supposed to need them.

The applicability of the various methods of treatment to the four groups of conjunctival affections already described is shown in the following brief statements of the results obtained.

Folliculosis (follicles scattered over an otherwise apparently normal conjunctiva).—In mild cases no treatment was used except boric acid solution (3 per cent) at home and an insistence upon observance of rules of personal hygiene. These cases were sent to the clinic once a month for examination or sent by the school nurse within that time if inflammatory symptoms supervened. The great majority of these cases, so far, have at present normal conjunctivas, and the others are practically normal (Table 1). In more marked cases bichlorid of mercury (1-500) rubbing with cotton swab was employed once a week. Marked improvement followed even one rubbing in some of these cases. In a few of the more chronic cases sulfate of copper stick was infrequently used. In this series of some 2,000 cases of folliculosis observed for from 2 to 4 years, we have not yet found it necessary to use expression. If the operation of expression is performed, it should be clearly explained to the patient that the disease attacked will not eventuate in deterioration of vision and that the operation itself may be followed by unpleasant consequences to both conjunctiva and cornea.

Follicular conjunctivitis (follicles scattered over a non-thickened inflammatory conjunctiva).—In these cases, if the superadded inflammation is acute and attended with secretion, argyrol, 20 per cent, or 1 per cent silver nitrate solution was first used. Later, bichlorid of mercury was rubbed on the inner surfaces of the lids. With Morax-Axenfeld diplococcus infection, sulfate of zinc (0.2 per cent) was used. In the few sluggish cases the bichlorid of mercury treatment was alternated infrequently with the bluestone pencil. The great majority of these cases recovered without the last-named treatment. The hygienic treatment at home and in the schools is insisted upon in all of the cases.

Papillary conjunctivitis (formerly called acute trachoma).—Argyrol, 20 per cent, or silver nitrate solution, 1 per cent, was used in the beginning in these cases, when there was usually more or less marked secretion. Later the bluestone pencil alternating with tannic acid (40 gr. to an ounce of glycerin) was employed. From time to time in the more chronic cases all medicinal treatment (except the home boric acid washing) was suspended for a variable period. After this, a certain number of the cases seemed to respond more favorably to the renewed medicinal treatment. Simple hygienic treatment for several months would probably be sufficient for a great number of these cases if we could have them under hospital care as Cohen and Noguchi had their cases which recovered in an average of 4 months after only boric acid and cold compress applications.

None of our patients with papillary conjunctivitis has been operated upon.

Old trachoma (cicatricial formation with or without pannus).—In our series of cases among the school children we have as yet had no cases passing into the cicatricial stage tho several have had pannus. Among our pannus cases only 8 have developed the pannus after being seen by us. Two of these left us and all of the other 6, none of whom has been operated on, now have clear corneas, except one who has a narrow rim of inactive haze over the upper part of each cornea. These cases, treated medicinally in the usual way—some of them by vaccine—are being carefully watched for further developments.

In the adult, of course, the condition of cicatrization, with its danger of probable supervention of corneal involvement, is complicated by the fact that the patient is usually a wage-earner. As Boldt very truly states, our estimation of the value of a method of treatment must depend largely upon its applicability. These chronic cicatricial cases as a rule, and in New York City almost invariably, are found among the working classes, who have neither the means nor the inclination to pursue any palliative or expectant plan of treatment, and for economic reasons it is in these cases, in the opinion of one of us (Wootton), that excision is pre-eminently indicated, and that in all cases in which the cornea has actually become involved, excision should be performed at once. Excision, however, does not always mean cure since a certain percentage of individuals in our old pannus cases have shown a continuation of the pannus in aggravated form after the operation of excision.

Acute catarrhal conjunctivitis.—When our laboratory workers found that hemoglobinophilic bacilli of the same type were found in many cases of acute, subacute, and chronic conjunctivitis, we made special efforts to follow up in our treatment all of the acute cases of conjunctivitis in the schools and in the homes of the children in order to eliminate this form of infection from chronic cases. We cannot yet tell whether the fact that we now have very few of the chronic papillary or follicular conjunctivitis cases is due to these preventive measures.

Vaccine treatment.[1]—The following is a tentative report on the results obtained from the use of subcutaneous doses of various vaccines in a few cases of eye infections at the Health Department clinic for infectious eye diseases. The favorable results obtained with tuberculin in phlyctenular and ulcerative keratitis confirm the reports of other investigators. The rapid cure of styes and infected meibomian cysts treated with staphylococcus vaccine accords with our expectations. The use of streptococcus vaccine for pannus and interstitial keratitis, suggested by Dr. Williams, is, as far as we know, new. Since it has been used less than three months, no positive statements can be made. The marked improvement, especially in Cases 1 and 2 which had previously been very recalcitrant, is most suggestive and encouraging.

STREPTOCOCCUS VACCINE.

PANNUS.

Case 1, 11 years old. Duration of sore eyes not known but under our observation almost 2 years. Her conjunctivas during this time presented deep-seated follicles on both upper and lower lids, at times with and at times without inflammatory symptoms but no corneal involvement, until 8 months after we first saw her.

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[1] For the report given here of vaccine treatment in these cases Dr. von Sholly is responsible.

October 29, 1912: Pannus developed in right eye. The von Pirquet test made at this time was negative. Daily treatments of atropin, hot applications, and ung. hydrargyri flav. ox., 2½ per cent into conjunctival sac, were given, with either bluestone or corrosive sublimate (1–500) rubbings twice a week. After little less than 3 months' treatment, the right cornea became clear again.

March 4, 1913: Pannus developed in both eyes but was more marked in right.

May 27, 1913: A Wassermann test was negative. The same treatment as above was instituted but very little improvement was noted.

June 30, 1913: Child was sent to our country camp but after 10 days returned on account of a death in the family. Until school opened, September 16, 1913, she was seen only twice and had marked pannus in both eyes covering half of cornea, and pronounced photophobia. All over her face there was also a scaly papular eruption which had been present all summer.

September 29, 1913: Twenty-five million streptococci (stock vaccine) were injected.

October 3, 1913: Fifty million were given. After the second injection, the pannus disappeared from the left cornea, leaving a very faint scar. The right cornea showed a marked recession of the pannus. After the third injection a week after the second, there remained only the lightest haziness of the extreme upper part of the right cornea.

November 11, 1913: After the fifth injection, the pannus had entirely disappeared.

December 6, 1913: Both corneas continue clear except for a scarcely perceptible scar in each. Streptococci were found in the cultures made from the conjunctival curettings. Curiously her skin condition improved also and now her skin is absolutely clear.

Case 2, 15 years old. "Sore eyes" 3 years.

February 12, 1912: Operation (expression) New York Eye and Ear Infirmary.

July 10, 1913: Came to our clinic with a papillary conjunctivitis of both eyes, more pronounced in right, marked and very active pannus covering more than half of right cornea and a small scar of a former ulcer on left cornea. The von Pirquet test was negative. In spite of this, she was given, in increasing weekly doses subcutaneously for 7 weeks, tubercle bacillus emulsion, beginning with 1/10,000 mg. At the same time atropin, hot applications, and yellow oxid of mercury ointment 2.5 per cent in conjunctival sac, were used daily. Bluestone was used at intervals. At the end of this time the very active symptoms had cleared up, but the pannus of upper half of right cornea persisted.

September 6, 1913: During the last week of the tubercle B.E. injections, the old ulcer on the left cornea became active. The T.B.E. injections were stopped.

September 16, 1913: An inoculation of 25 million streptococci (stock vaccine) was given. This was continued in doses increased by 25 millions once a week. In 16 days after the third injection the ulcer on left cornea was healed, leaving a very light scar which still persists (December 6).

October 23, 1913: The pannus of the right eye receded slowly after the sixth injection. The infiltration of the cornea, from being moderately dense, had become very light so that the iris could be clearly seen, and the blood vessels running in from the top had become reduced to only a few of the larger ones.

October 30, 1913: A mixture of streptococci (175 million) and *Sta. pyogenes aureus* (500 million) was injected.

November 1, 1913: There was a striking improvement noted. Only a little infiltration of the cornea was left at the top with one or two small vessels running into it.

November 11, 1913: The right cornea was almost normal except for a slight rim of cloudiness at extreme top.

December 6, 1913: There is still this small hazy rim at the top. The thickening of the palpebral conjunctiva has decreased so that the left palpebral conjunctiva, tho still reddened, has become thin enough to allow the palpebral blood vessels to show to a certain degree.

Case 3, 33 years old, married.

December 21, 1911: Came to the clinic with a cicatricial condition (non-operative) of both palpebral conjunctivas and sluggish pannus of both corneas. Duration of eye trouble 4 years or more. She was treated in the usual way with hot applications, atropin, yellow oxid of mercury ointment, and bluestone. She has continued under constant observation.

March 3, 1912: She had an acute exacerbation with intense vascular reaction of pannus first in right and then in left eye. The right cleared up under the above treatment.

July 27, 1912: While pannus was still acute in the left eye, patient was given 50 million polyvalent hemoglobinophilic bacilli. The injections in increasing dosage were given weekly for 9 weeks.

September 28, 1912: Both corneas had improved to such an extent that there was only a very light cloudiness of the upper fourth.

October 15, 1912: While these injections were still being given an active acute pannus started up in right cornea and on November 9, 1912, in left. The injections and local treatment were continued and in two weeks all active symptoms were gone, leaving the corneas slightly cloudy again at the top.

June 5, 1913: A mild exacerbation of pannus in left cornea appeared lasting only a few days. Mrs. L. was at this time pregnant. On August 21, her baby was born. Eight days later she appeared at the clinic with a very severe reaction in the left eye. There was a dense opacity of the whole cornea and marked ocular and ciliary injection.

September 4, 1913: Six days after onset, 25 million streptococci were injected. In 5 days improvement was noticeable,. By the seventh day, on which second injection was given, the improvement was marked, and by the ninth day the acute symptoms had subsided. After the fourth injection the corneas were clear except for slight blurring above and after the eighth injection on November 1, 1913, both corneas became quite transparent with no show of pannus. Streptococci, staphylococci, and xerosis bacilli were found in cultures.

Case 4, 10 years old, a thin, pale, and undernourished child.

March 4, 1912: "Follicular trachoma" and pannus in both eyes. Under daily local treatment and injections of vaccine of hemoglobinophilic bacilli, begun October 15. 1912. In December, 1912, 9 months later, the pannus in left had become less, and after another month the pannus had returned and covered upper half of right cornea and about upper third of left with a small active ulcer on left also. The child was sent to our country camp for 9 weeks. He gained 5 pounds and his general condition was much better, but the pannus, altho a little less dense, was present in both eyes.

September 11, 1913: A combined vaccine, streptococcus (25 million) and *Sta. pyogenes aureus* (200 million), was injected. Streptococcus vaccine alone was then given for 3 doses (weekly) and again the combined.

October 30, 1913: After the third injection of the latter, the pannus of left eye was entirely healed, leaving a very light scar, and the pannus of right was much less. The last injection was given November 16.

November 18, 1913: A few fine ulcers appeared on both corneas.

November 20, 1913: Tuberculin B.E. 1/10,000 was given.

November 25, 1913: The corneas had cleared and were more transparent than they had been since he was under operation. Left cornea shows only small scar and right the merest rim of infiltration at the top. After the second injection of tuberculin the cornea looked in good condition.

December 9, 1913: After the fourth injection, the pannus had returned to both eyes, now covering fully half of each cornea. Streptococcus injections now will be substituted for the tuberculin.

Case 5, 40 years old, married. Duration of disease 8 years. Combined excision of Heisrath 5 years ago. Canthotomy last year.

December 13, 1910: Came to clinic with pannus of both eyes, trichiasis. Under our observation and local treatment her pannus has receded and relapsed at varying intervals. She was given the hemoglobinophilic bacillus vaccine from May 2, 1912, to April 12, 1913, at first regularly and later rather irregularly. For a time there seemed to be marked improvement but later no effect. For a time she was under the care of another dispensary.

October 4, 1913: She returned with a very severe active vascular keratitis involving whole right cornea and part of left. She was given empirically 25 million streptococci. For three days after this injection she was somewhat worse, then began to improve the day following the second injection.

November 4, 1913: Fourth injection was given and on November 20, fifth injection. On this date, her right cornea was almost clear; there were no active symptoms and there was only a slight cloudiness of left cornea.

December 5, 1913: Both corneas were clear except slight blurring at top and there were no active symptoms.

Case 6, 17 years old. Came to clinic with severe double pannus. Could not work. Had a combined excision of palpebral conjunctivas and tarsal cartilages. Under daily local treatment and two injections of staphylococcus vaccine, he improved so much that he has not returned to clinic.

SPECIFIC KERATITIS.

Case 1, 15 years old. Double keratitis of several years' standing; dense opacity of both corneas.

December 12, 1912: Came to clinic. Von Pirquet test negative. Wassermann positive on January 4, 1913, and on September 16, 1913. Had two injections of salvarsan on February 8, 1912, and May 27, 1913, respectively. Wassermann still positive almost 4 months after second injection of salvarsan. Took mixed treatment by mouth.

June 30, 1913: Sent to summer camp for 9 weeks, when she improved considerably. In September her corneas presented a very light infiltration, and she could read and do her school work.

October 18, 1913: An injection of 25,000,000 streptococci. On the following day there was an intense ocular and corneal reaction, almost like that following the salvarsan. It lasted 4 days and left an increased cloudiness in the cornea.

November 11, 1913: Almost 3 weeks after the first injection the second injection of streptococci was given with no reaction. After the third injection following a week's interval, both corneas became clearer than they had been since her first visit to us. Five injections in all were given and now there are transparent areas in corneas with small faintly blurred areas.

TUBERCULOUS KERATITIS.

Case 1, 10 years old.

June 11, 1912: Came to clinic with dense mottled bluish-gray infiltration of left cornea with injection, photophobia, and discomfort. Palpebral conjunctivas normal. Under usual local treatment, she showed slight improvement by July 2.

July 16, 1912: A fresh ulcer with active symptoms appeared and by July 26, there was a distinct ectasia of cornea. The child again improved slightly under local treatment.

August 20, 1913: She received a blow on the left eye and appeared with a complete dense infiltration of cornea with ocular and ciliary injection.

October 8, 1912: Von Pirquet test gave a moderate reaction. Three days after this test was made, a fresh crop of small ulcers appeared in lower part of left cornea.

October 18, 1912: Tubercle bacillus emulsion 1/10,000 mg. was injected. This was given weekly, increasing each dose by 1/10,000 mg., until January 10, 1913, when 1/1,000 mg. was given. After the third injection the cornea had cleared sufficiently to show the pupil; by the sixth injection the cornea was transparent except for a few tiny macules.

January 10, 1913: The cornea looked so well that the tuberculin was stopped.

April 15, 1913: A small fresh ulcer with local injection appeared on the cornea and tuberculin B.E. was again begun at 1/10,000 mg. One week later the ulcer was healed, leaving a tiny scar. Injections were continued, however, and the dosage carried to 1/100 mg. on September 19, 1913.

August 5, 1913: The cornea was quite clear.

December 5, 1913: The last record shows that the cornea is still transparent except for a few very small almost imperceptible blurs which are seen only on close inspection. The patient has gained a good deal in weight and general condition since the T.B.E. was started.

Case 2, 9 years old. Sore eyes for 8 months.

May 18, 1912: Entered clinic with eye condition similar to Case 1, cornea ectatic. Gave a very pronounced reaction to the von Pirquet test both at site of vaccination and locally in eye. Within a few days after the von Pirquet test was made, there was a noticeable improvement in the eye before the injections were begun.

May 28, 1913: T.B.E. 1/10,000 mg. given.

June 8, 1913: The ectasia of cornea had disappeared and opacity was much less dense.

June 27, 1913: The lower part of cornea alone was hazy with scattered more dense flecks.

November 6, 1912: There was only the slightest blur on cornea. Patient had begun to be irregular in attendance.

January 7, 1913: Two fresh ulcers developed but left after a few days under tuberculin. The child was not seen then until March 6, 1913, when she reappeared with several small ulcers on upper part of cornea. 1/10,000 mg. T.B.E. given.

March 13, 1913: She had improved and was given a second dose of 2/10,000 mg. Recovered and remained away from clinic.

May 10, 1913: She appeared with tiny ulcer just above pupil. Otherwise her cornea was quite clear. An injection of tuberculin was given. She has not reappeared at the clinic.

Case 3, 13 years old.

October 22, 1912: Came to clinic with several small ulcers on corneas of both eyes. "Sore eyes" for 2 years. Had photophobia and blepharospasm.

December 20, 1912: Von Pirquet positive. Eyes showed same improvement after test as in Case 2.

December 24, 1912: Tuberculin B.E. begun. Increased gradually to 5/100 mg. by June 24, 1913.

January 14, 1913: Both corneas were clear, no photophobia, no blepharospasm.

January 28, 1913: A fresh ulcer appeared but cleared up rapidly.

March 11, 1913: Another small ulcer broke out which healed rapidly.

April 4, 1913: Both corneas were transparent.

May 25, 1913: Last ulcer appeared.

October 31, 1913: Both corneas were clear and have continued so. Only irregular injections were given after June, none at all during the summer. A few follicles have appeared on palpebral conjunctivas since under our care. They were probably stimulated by the local treatment of atropin, etc.

Case 4, 10 years old.

April 1, 1913: Came to clinic with a severe vascular keratitis covering whole right cornea with dense infiltration. Left cornea had old scars. Duration of eye trouble two years. Child had a healed tuberculous spine. Von Pirquet test positive.

April 11, 1913: Tubercle B.E. was begun 1/10,000 mg.

April 15, 1913: A slight ectasia of right cornea was noted.

May 13, 1913: There was much improvement and no active symptoms after 4 injections.

June 6, 1913: Right cornea was transparent except for a few macules.

June 28, 1913: Last injection 2/1,000 mg. was given. Both corneas were clear except for light blur over centers.

September 2, 1913: The condition was the same.

Case 5, two and one-half years old.

July 31, 1913: Came to clinic with left eye showing a complete deep lilac-colored infiltration of whole cornea, thickly vasculized and totally obscuring iris and pupil. Cornea looked as if it had ruptured and healed. Child had a tuberculous knee. Mother had died of tuberculosis.

August 2, 1913: Von Pirquet test positive.

August 15, 1913: Tuberculin injections beginning with 1/20,000 mg. B.E. were started. After the second injection the vessels disappeared from cornea and cornea took on a bluish-gray tinge. The process had gone too far to have any hope of saving the eye but the child's general condition and knee condition have improved wonderfully. From a peevish, fretful, pale child, he is now happy and cheerful, with a good color, and gets about well with a brace.

December 2, 1913: He was receiving 3/1,000 mg. T.B.E.

STAPHYLOCOCCUS PYOGENES AUREUS INOCULATIONS.

ACUTE CONJUNCTIVITIS.

Case 1, 50 years old. *Sta. pyogenes aureus* found in cultures.

September 18, 1913: Came to clinic with intense ocular injection, injection palpebral conjunctiva, with much discomfort, profuse watery and some mucopurulent secretion. At the end of two weeks' local treatment with silver nitrate solution argyrol, boric acid solution given daily by nurse at clinic, there was practically no improvement.

October 2, 1913: 1,000 million *Sta. pyogenes aureus* (stock vaccine) were injected. Two days later the eye was well.

INFECTED MEIBOMIAN GLAND.

Case 2, 40 years old. Abscess of meibomian gland ruptured into conjunctival sac and set up an acute conjunctivitis. Patient was a teacher anxious to return to work. Case was seen on third day, argyrol and boric acid advised. On the following day, the eye appeared about the same and staphylococcus vaccine (500 million) was injected into arm. The improvement on the following day was striking and the second day after the injection the patient returned to her work.

About a dozen other cases of infected meibomian glands, some of which had ruptured and some not, have been treated similarly with immediate and permanent results.

About 27 cases of styes, many of them recurring ones, have been given staphylococcus injections, varying from 1 or 2 to 6 injections, with very satisfactory results.

V. MICROSCOPIC AND CULTURAL STUDIES.

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Having soon reached the conclusion mentioned in the review of the literature (p. 262), that, notwithstanding the voluminous publications on the subject of the bacteriology of conjunctivitis, only a few comprehensive bacteriologic studies have been reported; and at the same time being impressed from our early microscopic studies with the resemblance in morphology and staining reactions of the trachoma, or Prowazek, inclusions to dense groups of small bacteria, we determined to make, in connection with the clinical work, as exhaustive a cultural and microscopic study of our cases as was practicable with the facilities at hand and with our present knowledge of the characteristics of pathogenic microorganisms.

Technic.—When we began our cultural studies each case showing any inflammation of the conjunctiva, after being clinically examined and recorded as given in Sec. II, was subjected to the following microscopic and cultural examinations. A light, but thorough curettage was made with an eye curette, usually over the upper tarsal and *cul de sac* regions. The curetted material was used chiefly for the films, but occasionally some of it was cultured. The films were made by cover glass pressure, were fixed immediately in methyl alcohol, C.P., and were stained over night in Giemsa's solution (see Gurley and Chase for details of method of staining). Other stains, Gram's, methylene blue, fuchsin and methylene blue mixture, etc., were used from time to time.

The majority of the cultures were made as follows: Over the freshly curetted conjunctival surface was rubbed a sterile cotton swab which was placed immediately into a 10×1 cm. tube containing a mixture of veal broth and rabbit or horse blood (10:1), about 3 cm. deep. The tube was then sent to the laboratory where further cultures were made. This preliminary blood-broth culture acts in two ways: (1) immediately, as a diluent in cases where many organisms are present, and (2) after growth in the incubator, as an enricher, especially for the group of hemoglobinophilic bacilli and for the gonococcus. From this blood-broth tube stroke cultures were made on plain veal agar, ascitic-glucose-agar, and blood-(rabbit or horse) veal-agar, and in deep tubes of these media containing agar, inoculated while fluid, allowed to harden and then covered with more melted agar and, when solid, with albolene. Cultures, including the original tube of blood-broth, were kept at 36° C. and examined in from 18 to 24 hours, when a second series of cultures was made from the original blood-broth culture, diluted when necessary. Fishings and films were made from plates, and all cultures were returned to the incubator. In 48 hours fishings and films were made again and all cultures were studied for varying times. The deep tube cultures were observed for anaerobes and were examined in from 4 to 10 days. These deep tube cultures were discontinued after a short time since we found no organisms growing in the depths that did not grow in the blood-broth tubes.

After we had examined in this way a number of conjunctivitis cases, we concentrated in cultural work on those diagnosed clinically as active trachoma, as suspicious, and as doubtful cases or beginning trachoma. From time to time through overfull clinics a number of these cases did not receive this complete examination, but such cases were recorded and examined later if they continued to be of interest. Only a few folliculosis cases were thus examined, and many of the acute catarrhal conjunctivitis cases cleared up too quickly for a later culture study.

In a number of cases before cultural studies were begun when we were interested chiefly in the morphologic examination of the trachoma, or Prowazek, inclusions, we studied only smears; and in a number of cases later, especially of acute contagious conjunctivitis, where our chief point for a time was to determine the prevalence of the group of hemoglobinophilic bacilli as well as the relation of our hemoglobinophilic strains to the influenza bacillus and the Koch-Weeks' bacillus, we studied only cultures.

Eight hundred and twelve cases were examined by cultures, 500 cases by direct smear (chiefly for Prowazek inclusions), and 400 cases by both cultures and direct smears.

The 812 cases examined by cultures were obtained from the following places:

Cases from New York City school children and their families:	
Borough of Manhattan (lower East Side)	607
" " Bronx (upper East Side)	38
" " Brooklyn	9
New York City Eye and Ear Hospital	21
Blackwells Island	19
Ellis Island	16
Home for Feeble Minded	79
Kentucky Mountains	13
Miscellaneous	10
	812

We see by glancing at Table 3 that the hemoglobinophilic bacilli (excepting staphylococci which were present in practically all conditions in varying numbers) were found most frequently in these cases, particularly in the cases diagnosed as papillary conjunctivitis (at first called acute trachoma) and acute conjunctivitis. The first strains of this group that we isolated from cases diagnosed clinically as trachoma were so extremely small and coccus-like that we thought we were dealing with a new variety, but we soon found that the different strains varied somewhat in size, and that the same strain in subsequent culture generations varied in the same particular. When we found that all the strains isolated from our acute conjunctivitis cases, including all cases of clinically typical "pink eye," as well as from our subacute and chronic conjunctivitis cases, were strictly hemoglobinophilic, we came to the conclusion that these bacilli must be classed, at least provisionally, as influenza bacilli, and much of our subsequent study was directed toward determining whether these strains might be divided into distinct species or varieties of the influenza group or whether they all belonged to the one species, *B. influenzae.*

We recognized further that from a clinical standpoint, too, it was important to determine the relationship of our strains to the Koch-Weeks bacillus, since so many of our acute cases were clinically typical "pink eye," or acute contagious conjunctivitis, and since several of our early cases passed from this condition to that of papillary conjunctivitis showing trachoma inclusions. So we set about systematically hunting for the classic Koch-Weeks bacillus. For this purpose we chose a series of early marked typical "pink eye" cases before treatment and submitted them to our microscopic and cultural technic. In all of these we obtained in our original tubes and plates abundant and practically pure growths of a strictly hemoglobinophilic bacillus similar to our other strains. We fished from many different colonies in each plate, but no classic Koch-Weeks bacillus was found. The original smears showed bacilli sometimes larger (the Koch-Weeks bacillus?), sometimes smaller (the influenza bacillus?), but only abundant hemoglobinophilic bacilli grew. That we may have missed a bacillus answering to the classic Koch-Weeks bacillus is possible. One has only to remember the history of the demonstration of the Bordet-Gengou bacillus to realize how unwise it is to draw hasty conclusions from resemblances between morphology in cultures and that in direct smears. In these pertussis studies at first only hemoglobinophilic bacilli were isolated from pertussis cases. Finally the distinct variety, *B. Bordet-Gengou*, was grown. It may be that we in the same way have not yet been able to grow

TABLE 3.

SHOWING CLINICAL DIAGNOSES AND CULTURAL FINDINGS.

Diagnoses	Total No. Cases	Hemoglobinophilic B.	Pneumostreptococcus Group	Str. pyogenes Hemolyzing	Gonococcus	Morax Axenfeld	Tetragenus	Yeast	Diphtheria	Typhoid Colon Group	Sta. Pyogenes	Xerosis B.	No Growth	M. catarrhalis
Old trachoma	59	9	14	....	....	1	....	....	....	1	35	25	....	....
Papillary conjunctivitis	237	147	60	2	5	6	2	5	....	4	190	95	1	....
Follicular conjunctivitis	145	49	6	1	0	8	....	....	....	4	130	65	....	....
Acute conjunctivitis	271	204	95	4	8	2	....	....	2	5	250	156	2	3
Folliculosis	45	0	0	....	....	....	....	....	....	....	19	15	23	....
Other conditions	55	15	18	....	....	....	....	....	....	3	32	31	....	....
Total	812	424	193	7	13	17	2	5	2	17	656	387	26	3

the classic Koch-Weeks bacillus. While we do not believe this, all we can positively say is that in this large series of cases of clinically typical "pink eye" we have secured in direct cultures abundant growths of a strictly hemoglobinophilic bacillus, which answers to the description of the influenza bacillus rather than to that of the classic Koch-Weeks bacillus. And this fact has led us to agree with those who consider the Koch-Weeks bacillus a strict hemoglobinophile, indistinguishable so far from *B. influenzae*.

The following tests were made in order to help determine the characteristics of our strains.

Hemoglobinophilic tests.—We went very minutely into the question of the hemoglobinophilic property of our strains. Most of the experiments relating to this point were made by Miss Mishulow. Besides the preliminary attempts to cultivate these strains on blood-free media, we made repeated attempts from time to time on a larger number of the older strains, all with negative results. We tried to accustom the strains to growing without blood by growing them in gradually diminishing amounts of it. We found that tho they grow well in amounts up to 1–1,000 (horse blood), the growth stops after a variable number of culture generations when this amount is lessened. Horse hemin crystals[1] in veal agar or broth in dilutions of 1 to 100 and 1 to 1,000 gave no growth after the third culture generation.

Horse serum, obtained by drawing the blood in sodium citrate and, after allowing the red blood corpuscles to settle, pipetting off the clear supernatant fluid, gives variable results. Some sera allow growth for many generations and others for only a few. In the former case it cannot be denied that the positive result is probably due to the presence of a minute amount of hemoglobin. When we remember that in 1 to 1,000 blood dilution it is only detected by a more delicate test than the spectroscope, e.g., Adler's benzidene test, we may realize how easily, by the method used for obtaining the serum, hemoglobin in amounts large enough to allow growth might be present and might escape detection. The positive cultures claimed for the Koch-Weeks bacillus in media containing "rich hydrocele or ascitic fluid" may be explained by the presence of such a minute amount of hemoglobin.

Symbiosis tests.—In connection with the attempts to make these strains grow without hemoglobin, we carried on a number of so-called "symbiosis" tests, i.e., we grew certain strains on blood-free agar and broth coincidentally with other bacteria. The results obtained on blood-free veal agar are condensed in Table 4. All these tests were repeated with practically the same results. In blood-free broth Strains 636 and 351 (hemoglobinophilic) grew well with xerosis bacillus for 12 culture generations. B.I. 1 (influenza bacillus) was negative on the sixth generation in the first test, but had a growth on the eighth in the second; while B.I. 2 (influenza bacillus) failed to grow beyond the seventh culture generation in this fluid medium. As plain and blood-veal agar and broth were used as controls in this work we had a further test of the hemoglobinophilic property of these strains. Many individual tests were made of symbiosis on plates as well as in tubes, which bore out the results shown in Table 4, namely, that all the organisms tried, except *B. xerosis*, *B. diphtheriae*, and the gonococcus, interfered with the growth of these strains. This is entirely contrary to all statements in regard to the influence of the staphylococcus on this group of organisms, and we cannot explain the apparent contradiction. It is true that on plates, if the staphylococci are few, isolated colonies of the hemoglobinophilic bacilli on the first culture generation from a blood-agar medium or on blood-agar media may be larger in the neighborhood of staphylococcus colonies, but only incidentally so, we believe. Attempts at symbiosis growths with cultures of staphylococci, xerosis bacilli, or diphtheria bacilli killed at 60° C., the first two for one and one-half hours and the last one for 15 minutes, were negative after 3–7 culture generations. The practical fact learned from this study is that when many staphylococci are present coincidentally with hemoglobinophilic bacilli in a case of conjunctivitis, the former may interfere with the isolation of pure cultures of the latter.

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[1] Isolated by Mr. Atkinson.

TABLE 4.

GROWTH OF HEMOGLOBINOPHILIC BACILLI IN SYMBIOSIS ON BLOOD-FREE VEAL AGAR.

STRAINS OF HEMOGLOBINOPHILIC BACILLI	STA. PYOGENES		STAPHYLOCOCCUS + STREPTOCOCCUS		XEROSIS		XER. + STREPTOCOCCUS		STREPTOCOCCUS		GONOCOCCUS		DIPHTHERIA		B. HOFFMANNI	
	Gen.	Growth	Gen.	Growth	Gen.	Growth	Gen.	Growth	Gen.	Growth	Gen.	Growth	Gen.	Growth	Gen.	Growth
636	1	—	1	—	20	+	3	—	4	—	19	++	12	±	2	—
351	.....	.....	.....	.....	20	++	2	—	2	—	20	++	12	±	5	—
BI. 1	1	—	1	—	5	—	3	—	4	—	20	+	11	±	4	—
BI. 2	.....	.....	.....	.....	14	++	.....	.....	.....	.....	.....	.....	12	±?	2	—

In order to try to inhibit the growth of the staphylococci in mixed cultures and allow the growth of hemoglobinophilic bacilli, Churchman's gentian-violet test was made by Miss Wilson and Miss Mishulow. Details of these tests are as follows: Dilutions, ranging from 1–50 to 1–1,000, of a saturated aqueous gentian-violet solution were made in sterile blood-broth. These dilutions were distributed into small test tubes, and inoculated with practically equal quantities of 24-hour agar cultures of Strain 636 (hemoglobinophilic), *Sta. pyogenes aureus* and xerosis bacilli in pure culture and in mixtures. Controls of each were made in blood-broth. Blood-streaked plates were made of these cultures immediately after inoculation and also after ½, 1, 2½, 24, and 48 hours' incubation at 36° C. These plates were examined after 24 hours', 48 hours', and 3 days' incubation. On the whole the best results were obtained after 1 hour's incubation in the gentian-violet-blood-broth.

The results, as indicated in Table 5, show that altho the growth of the gram-positive organisms was not completely inhibited in the mixtures which gave a good growth of the hemoglobinophilic bacilli, it was restricted to a considerable extent. Thus in the controls of the mixed cultures the plates had a heavy growth of *Sta. pyogenes aureus* after 24 hours' incubation and were completely overgrown after 48 hours; whereas, on the plates of the gentian-violet cultures, even when there was a good growth of *Sta. pyogenes aureus*, it was not heavy and the colonies were discrete. Two plates of the mixed cultures of Strain 636 and *Sta. pyogenes aureus* on the 1–50 dilution, one made immediately after inoculation, and the other after one hour's incubation, had a pure growth of hemoglobinophilic bacilli in the center and a good growth of *Sta. pyogenes aureus* on the margin of the blood zone. Also several plates of a pure culture of *Sta. pyogenes aureus* on 1–50, 1–100, and 1–200 dilutions showed a similar growth. Evidently the growth of *Sta. pyogenes aureus* was inhibited in the center of the plate by the presence of a small quantity of gentian-violet carried to the plate with the culture, since the loopful of material is placed in the center and then radiated from the center.

TABLE 5.

ONE-HOUR GENTIAN-VIOLET BROTH EMULSION.

Culture	636 + Sta. + Xer.			636 + Sta.		636 + Xer.		636	Sta.
Control	±̲	+++	++	–	++	+	+	+	++
G.V.Dil. 1–50	±̲	–	–	–	–	±̲	±̲	–	–
1–100	±̲	–	+	±̲	++	–	±̲	±̲	±
1–200	±̲	–	±̲	–	+	±	±	±̲	+
1–400	+	+	+	+	+	+	++	+	±
1–500	+	±̲	±̲	+	+	+	+	+	+
1–600	+	+	+	+	+	+	+	+	+
1–800	+	+	±	+	±	+	+	+	+
1–900	+	±	+	+	+	+	+	+	+
1–1,000	+	+	±	+	+	+	+	+	+
3-day gentian-violet plate all dilutions	–	–	–	–	–	–	–	–	–

±̲ indicates very slight growth. ± indicates slight growth.

The same dilutions of gentian-violet used in the blood-broth tests were made in liquid agar at a temperature of 55° C. and plates poured immediately. When they were solidified a drop of rabbit's blood was put in the center of each plate. Cultures of hemoglobinophilic bacilli (636), *Sta. pyogenes aureus*, xerosis, in mixtures and alone, as before, were inoculated into blood-broth and from these the gentian-violet and control plates were made. The growth on the gentian-violet plates was negative on all dilutions, while the control plates showed growth as indicated in Table 5.

We found by this study that by using the first method described, i.e., inoculating a blood-broth-gentian-violet medium with material containing hemoglobinophilic bacilli in mixed culture with staphylococci, we might expect material aid in isolating pure cultures of the former. Unless all aids possible are used in a cultural study of these cases, we feel that a certain percentage of infections with hemoglobinophilic bacilli as well as other microorganisms may be missed.

Virulence tests.—In connection with the study of antibody production by Dr. Povitsky a comparatively few tests were made of the degree of virulence possessed by our strains for rabbits and guinea-pigs. The results indicate on the whole a similarity to strains of hemoglobinophilic bacilli isolated from other parts of the body. That is, recently isolated strains are irregularly virulent for rabbits and guinea-pigs on intraperitoneal inoculation, and the virulence which is rapidly lost on artificial cultivation may be markedly increased for a species (guinea-pigs) by successive animal passages.

Eight monkeys, 4 macacus species, and 4 dog-faced baboons, were inoculated into the conjunctiva with 48-hour cultures of 8 different strains. One out of the 8 (a macacus) showed, after repeated inoculations, a subacute conjunctivitis, during the course of which a few superficial follicles developed.

Agglutination tests.—A strain of hemoglobinophilic bacilli from an Ellis Island case (a deportable trachoma case from Poland) produced agglutinins of 1 in 2,400 for itself and one from our public-school "trachoma" cases, but not for two other public-school strains or the strain from influenzal meningitis. Other strains, however, from public-school cases produced agglutinins for this meningitis strain.

The only inference we can draw from these studies is the same as that drawn from studies on agglutination in hemoglobinophilic bacilli from any other source; namely, that in the hemoglobinophilic group of bacilli there are distinct varieties as regards agglutinin production, but that these varieties seem not to be related to any definite set of morphologic characteristics or clinical symptoms.

The *complement-binding test* has not yet given satisfactory results. This is chiefly because no antigen has been obtained that would show a specific fixation, apparently because of the serum content of the culture media used. Recently, by growing organisms on media containing a minimum amount of heated blood, i.e., coagulated blood-agar (1 part of blood in 500 parts of agar, at 90° C.), we are apparently beginning to make good antigens. It may be that, with further testing, the fixation of complement phenomenon may help in a study of these strains.

During the attempts to obtain a good antigen, we have tried various methods of obtaining abundant growths of our strains in a medium containing no substances that might interfere with good antigen production. Thus we again tried to lessen the serum content of our medium by gradually diminishing the amount of blood used, but we found, as before, that beyond 1–500 dilution we were likely to get scant growths and beyond 1–1,000 no growth. Even in the dilution of 1–500 the growth is not always abundant unless the blood is added to very hot agar. A temperature of 90° C. seems to be sufficient to destroy something in the blood that is deleterious to growth, for Dr. Povitsky has found that growth is very luxuriant on media made in this way. On salt-free blood-agar, growth is as abundant as on the mixture of ordinary veal-agar and blood.

So far, however, neither the complement-binding test nor any other test tried has helped us differentiate our hemoglobinophilic strains from *B. influenzae* or the Koch-Weeks bacillus. Until we can make this differentiation we must consider all of these organisms as possibly identical in potential pathogenic power; just as we consider a pneumococcus isolated from the eye similar in possible pathogenicity to a pneumococcus from any other source.

RELATION OF HEMOGLOBINOPHILIC BACILLI TO TRACHOMA INCLUSIONS.

In studying closely the morphology in cultures of these bacilli, we were struck by the fact that they frequently grew in more or less dense clumps of extremely minute and irregular coccoid forms. This led us to the conclusion that possibly they formed the trachoma, or Prowazek, inclusions, and when we found that these bacilli and the inclusions were found coincidently and repeatedly in so many cases diagnosed as acute papillary trachoma (see Table 6, p. 320), the possibility became a probability and we proceeded to study the morphology of the cultures more minutely. Each culture was kept under observation for many days. Each day spreads were made from the same culture and stained by Giemsa's method exactly as we stain our direct films for the detection of the trachoma inclusions. In examining these smears we found that cultures of these bacilli, as they grew older, altered significantly both in their morphology and in their staining reactions to Giemsa. Twenty-four-hour cultures show dense clumps of short bacilloid or coccoid forms taking a comparatively deep blue stain exactly as do the early granules of the trachoma inclusions (the "initial bodies of Lindner"). The morphology varies somewhat with the age of the inoculated culture, the date from isolation, the kind of medium, and the strain. In 48 hours the forms become somewhat more irregular. Then in 3 days most of the bacilli have become extremely minute, many showing only as reddish granules (the "elementary bodies of Prowazek"), while scattered through the culture are swollen spheroidal bodies taking a fainter clear blue stain (the larger "initial bodies of

TABLE 6.

COINCIDENCE OF HEMOGLOBINOPHILIC BACILLI AND TRACHOMA INCLUSIONS IN CASES EXAMINED BOTH BY DIRECT SMEARS AND BY CULTURES.

Diagnosis	Trachoma Inclusions		Hemoglobinophilic Bacilli		Remarks
	+	−	+	−	
"Old trachoma"	9	12	7	14	Seldom any growth on original plates. Growth in "enriching media."
Papillary conjunctivitis	184	53	177	90	In many of the recovering cases bacilli and "inclusions" are found irregularly.
Follicular conjunctivitis	2	22	14	10	
Acute catarrhal* conjunctivitis	17	71	45	43	Among these cases are included 38 cases of gonorrheal ophthalmia, 9 of which showed trachoma inclusions and recovered in from 3 weeks to 2 months. The others were cases of acute catarrh accompanied by hemoglobinophilic bacilli which recovered in average of 6 weeks.
Folliculosis	0	18	0	18	No "carriers" found.
Other conditions	0	12	4	8	Most of these cases were blepharitis and keratitis accompanied usually by slight catarrh. Examined only one in this way.

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* A number of cases (20) diagnosed first as acute contagious conjunctivitis developed later papillary conjunctivitis. These are included here among the papillary conjunctivitis cases.

Prowazek"), in some of which are minute reddish granules (more of the "elementary bodies of Prowazek"). A number of irregular light blue bodies are also scattered through the culture. Where the bacteria are densely grouped more red granules may appear in the center of the group than at the periphery and more blue bodies at the periphery than in the center. In short, all of the changes described by Prowazek and others as characteristic of trachoma inclusions are seen in the growing cultures of these hemoglobinophilic bacilli (Plate 2, Figs. 1–6, inclusive).

Similar day-to-day studies were undertaken with the other types of bacteria found most frequently in the eyes diagnosed as trachoma, e.g., streptococci, staphylococci, gonococci, a minute gram-negative, non-hemoglobinophilic bacillus not before described, found in a few cases of papillary conjunctivitis, xerosis bacillus, and *Micrococcus tetragenus*, but in none of these varieties except the gonococcus were similar changes found in the same marked degree. Cultures of the tetragenus coccus, isolated repeatedly from a case of chronic conjunctivitis, showed some dense bunches but practically no red granules. This corresponded with what was found in direct smears from the case. Many of the epithelial cells contained the tetrads, some distinct and some in dense clumps, approaching in morphology the early trachoma inclusions found in ophthalmia neonatorum, but no forms containing reddish granules were seen.

The fact that the gonococcus cultures showed such definite appearances similar to the trachoma inclusions led us to make a special study of a series of ophthalmia neonatorum cases, 38 in all. The cultural technic employed was the same as that used for the other cases and we were on the lookout particularly for gonococci and hemoglobinophilic bacilli. In most of these 38 cases, treatment had already been begun when our cultures and films were made; in fact, many of the cases were already near recovery, so we were not able to get a complete cultural and morphologic picture; however, the results as given in Table 7 are rather suggestive. Gonococci were demonstrated by us in both smears and cultures in 10 cases, in smears alone in 9 cases, in cultures alone in 3 cases, and in neither culture nor smear in 16 cases. Most of the cases giving negative results and some of the others were examined several times. This picture of irregular results is one that might be expected from recovering cases. From only three of these cases were hemoglobinophilic bacilli isolated. In 9 cases definite trachoma inclusions were seen, in only one of which hemoglobinophilic bacilli were found as well, while in 7, gonococci were found. In two showing trachoma inclusions no definite organisms were demonstrated in either smear or culture. A minute study of the direct smears from these eyes apparently throws more light on the subject. In all of the inclusion cases where gonococci are

TABLE 7.

COINCIDENCE OF TRACHOMA INCLUSIONS, GONOCOCCI, AND HEMOGLOBINOPHILIC BACILLI IN CASES OF OPHTHALMIA NEONATORUM.

NUMBER OF CASE	SMEARS			CULTURES		CASE TERMINATION (WEEKS)
	Trachoma Inclusions	Transition Forms	Gonococci	Gonococci	Hemoglobinophilic Bacilli	
1	−	−	−	−	−	4
2	−	−	−	−	−	4
3	−	+	+	−	−	5*
4	+	+	−	+	−	5*
5	−	−	−	−	−	5*
6	+	+	−	+	−	8*
7	−	+	+	−	−	8
9	+	+	+	−	−	3*
M 1	−	−	−	−	−	4
M 2	−	−	−	−	−	2
M 3	+	+	+	−	−	3*
M 4	−	−	−	−	−	2
M 5	−	−	−	−	−	5*
M 6	−	−	−	−	+	6*
M 7	−	−	−	−	−	5*
M 8	−	−	−	−	−	4*
M 9	+	−	−	−	−	5*
M 11	−	−	−	−	−	2
M 12	−	−	+	+	−	4*
M 13	+	−	−	−	−	4*
M 14	±	+	+	−	−	4*
M 16	−	+	+	+	−	7
M 18	−	−	+	−	−	2 (died)
M 19	−	−	−	+	−	3 "
M 20	−	+	+	−	−	4
M 21	−	+	+	+	−	4
B 136	−	−	+	+	−	8
1,682	+	+	+	+	−	7
1,686	−	−	+	+	−	6*
1,687	−	−	−	−	−	2
1,707	−	−	−	−	−	2
1,708	−	−	+	−	+	3
1,709	−	−	+	+	−	3*
1,710	−	−	−	−	−	2
1,714	−	−	+	−	−	8
1,715	−	−	+	+	−	3
1,716	−	+	+	+	−	6
1,720	+	+	+	+	+	4

* Reported well when they left the hospital just before our last visit.

found, apparent transition forms between gonococcus and inclusion are very evident, and we find from a further microscopic study of these slides that the inclusions on the whole present certain characteristics different from those found in our series from school children, produced, according to our hypothesis, by nests of growing hemoglobinophilic bacilli. The inclusions, produced as we think by the gonococci, are characterized (1) in early stages by being more definitely coccus-like at the periphery of the clump and more densely clumped in the center; (2) in the later stages by showing on the whole smaller red granules than those produced by the hemoglobinophilic bacilli. These same differences are observed in a comparative day-to-day study of pure cultures of these two species of bacteria (compare Figs. 7–12 inclusive in Plate 2). We have found that different strains of each species vary in size of granules produced, hence the second characteristic is not a clean-cut one.

From this comparative morphologic study of "inclusions" and cultures we have reached the following conclusions:

1. The well known power of epithelial cells of the conjunctiva as well as epithelial cells of other parts of the body to harbor foreign invaders (e.g., erythrocytes, leukocytes, several species of microorganisms, notably gonococci and hemoglobinophilic bacilli) may be in evidence in any stage of inflammation.

2. Under certain conditions of infection, chief of which are, probably, a lessened virulence on the part of the invading organism and a lessened susceptibility on the part of the invaded cells, or one or the other of these conditions, some invaders (notably gonococci and hemoglobinophilic bacilli) may grow to a varying extent within the cells in groups or nests and thus produce the characteristic changes described as trachoma inclusions.

3. Under these conditions, too, growth of the invader may not be limited to the epithelium alone but may extend to the deeper tissues. According to the extent and kind of irritation produced by such growth, a variable degree of proliferating inflammation of the surrounding tissue may be established, which later, if unchecked, may go on to the formation of fibroid tissue.

If it be true that both gonococci and hemoglobinophilic bacilli (and possibly other species of bacteria) may grow in epithelial cells in nests presenting a morphologic cycle similar to that described for the trachoma inclusions, it explains, as one of us (Williams) has pointed out, the contradictory findings reported in cases of "inclusion ophthalmia," gonorrheal conjunctivitis, and *inclusion inflammation* in the mucous membranes of urethra and vagina ("trachoma of the urethra or vagina"[?]) and of other parts of the body. That is, in a large number of cases of "papillary conjunctivitis" and a certain number of cases of ophthalmia neonatorum, as well as in a certain number of cases of inflammation of the mucous membranes of other parts of the body (e.g., vagina, urethra), the trachoma inclusions found are due to one or more varieties of hemoglobinophilic bacilli; in a certain number of cases of gonorrheal ophthalmia as well as in gonorrheal inflammation of the mucous membranes of other parts of the body, the trachoma inclusions are due to the gonococcus.

According to one of the later reports of Leber and Prowazek and the recent report of Noguchi and Cohen, certain inclusion conjunctivitis cases may be caused by microorganisms other than the two mentioned above.

OTHER MICROORGANISMS FOUND.

Since several varieties of organisms other than the hemoglobinophilic bacilli and the gonococci are frequently present in cases diagnosed clinically as trachoma, the question of their action may now be discussed. Of course, from practically all cases with any secretion more than one variety of microorganisms may be grown. Particularly is this true when a fluid medium is used for an original culture. Just how far enriching fluid media may be relied upon to aid us in determining the pathogenicity for the host of the organisms isolated by this method has not yet been accurately determined. We know, however, that under certain conditions, organisms exerting an active pathogenic action in the body of the host are difficult to isolate and to grow immediately after isolation on artificial culture media. An enriching medium under these circumstances may be the only means to demonstrate the most harmful organism present. But, without doubt, it cannot give us a correct idea of the number of organisms present in the lesion at the time the culture was taken. We must have in mind these and other questions already considered when we try to interpret all of the bacteriologic findings in these studies.

Staphylococci.—We see by Table 3 that the *Sta. pyogenes* group was demonstrated in nearly all of the cases. But in only comparatively few of these did a large number of colonies grow on the original plates, and these cases presented no uniform or related clinical picture. Original plates from the great majority of the cases showed few or no staphylococcus colonies. In the latter case, the enriching medium used showed them after 24 hours.

The well known power of the group of *Sta. pyogenes* to vary in pathogenicity, coupled with the effect of the varying degrees of susceptibility or immunity of the host, could produce, as many have pointed out (see Duane and Hastings), many grades of pathogenic action. To determine the exact conditions and limits of pathogenicity of this group would require much more work than we have been able to give in this study. We do know, however, that this group of organisms has been found in a number of cases of ulcer of the cornea, and in several cases of acute follicular conjunctivitis, acute exacerbation of trachoma, and acute pannus as apparently the predominating organism present (judging from growth on original plates) in the curetted conjunctiva.

It seems, then, that in certain cases these cocci may play a most important part, not only in certain definite infections, but also in helping along a case of follicular conjunctivitis to become a "bad case of trachoma."

Streptococci.—We see by reference again to Table 3 that many streptococci were found. These were all of the short-chained, non-hemolyzing type. In order to help determine the relationship of these strains to the great group of pneumo-streptococci, 20 strains isolated respectively from 20 successive cases showing these streptococci in original cultures were studied for both their hemolyzing and their fermentative powers. Table 8 (p. 326) shows the condensed results of this study.

We see by studying this table that 45 per cent of these strains are typical pneumococci, while 55 per cent may be classed as

TABLE 8.*

FERMENTATION AND HEMOLYSIS TESTS OF PNEUMO-STREPTOCOCCUS GROUP.

CULTURE		MILK			NEUTRAL RED			SACCHA-ROSE		LACTOSE		RAFFINOSE		INULIN			SALICIN		MANNITE		HEMOLYSIS	
		Test	Clot	Acid	Test	Reac-tion	Gas	Test	Acid	Test	Acid	Test	Acid	Test	Acid	Clot	Test	Acid	Test	Acid	Green Pro-ducer	Hemol-ysis
Pneumococcus	21-79	3	+	+	2	−	−	1	+	1	+	1	+	4	+	−	2	+	2	−	+	±
	H 1,658	3	+	+	2	+	−	1	+	1	+	1	++	4	+	−	3	+	3	−	++	−
	545	2	+	+	1	−	−	1	++	1	++	1	+	2	$\underline{\underline{\pm}}$	−	3	?	3	− ?	+	−
	J 38	2	+	+	1	+	−	1	++	1	++	1	++	4	+	−	2	+	3	+	++	−
	150(?)	2	−	+	1	+	−	1	++	1	++	1	+	3	?	−	2	+	3	− ?	++	−
	PS 371	2	+	+	1	+	−	1	+	1	++	1	++	3	±	−	2	+	2	−	++	−
	H 2,225	2	+	+	1	−	−	1	±	1	++	1	++	3	+	−	2	$\underline{\pm}$	2	−	++	−
	PS 108	2	+	+	1	−	−	1	++	1	+	1	++	2	±	−	2	+	2	− ?	++	−
	21-394	1	+	+	1	+	−	1	++	1	++	1	++	1	$\underline{\underline{\pm}}$	−	1	++	1	− ?	+	−
Type A	Res 375	3	+	+	2	+	−	1	+	1	+	1	$\underline{\underline{\pm}}$	3	−	−	3	− ?	3	−	++	−
	2,185 A	2	$\underline{\underline{\pm}}$	+	1	+	−	1	$\underline{\pm}$	1	+	1	±	4	−	−	2	−	3	−	+	−
	562	2	+	+	1	+	−	1	++	1	++	1	−	4	−	−	2	−	3	−	++	−
	1,035	1	+	+	1	++	−	1	++	1	++	1	++	1	−	−	1	−	1	−	+	−
Type C	M 19 Re	3	+ ?	+	2	−	−	1	+	1	+	2	?	4	−	−	3	− ?	3	−	+	−
	G 520	2	+	+	1	−	−	1	+	1	++	1	−	3	−	−	2	?	3	− ?	+	±
	H 2,224	2	−	+	1	−	−	1	+	1	+	2	−	2	−	−	2	?	2	− ?	++	−
Unclas-sified	311 A	2	+	+	1	+	−	1	±	1	++	1	$\underline{\underline{\pm}}$	2	−	−	2	++	2	− ?	+	−
	21-290	3	±	+	2	+	−	1	+	1	+	1	+	4	−	−	3	+	3	−	+	−
	2,253	1	+	+	1	+	−	1	+	1	+	1	+	1	−	−	1	++	1	−	+	−
	G 174	1	−	+	1	+	−	1	+	1	+	1	−	1	−	−	1	+	1	$\underline{\pm}$	−	$\underline{\pm}$

* Elser's technic was followed in making the sugar media. Observations were made up to two weeks. After one week no further change was seen. ++ = Very marked acidity; +, marked acidity; ±, moderate acidity; $\underline{\pm}$, slight acidity; $\underline{\underline{\pm}}$, trace of acidity.

Str. viridans (producing in blood-agar plates a green halo about each colony instead of a zone of hemolysis), or if Gordon's classification is used, we could have the latter divided into *Str. pyogenes*, 15 per cent, *Str. salivarius*, 20 per cent, and unclassed streptococci, 20 per cent.

The fact that so many of these streptococci are of the type that is supposed to produce chronic inflammations in other parts of the body (e.g., in chronic articular rheumatism, endocarditis, etc.) is very significant. They seem to be more frequent in the subacute and chronic cases. In the pannus cases studied where they are very frequent, the part played by these streptococci may be of great importance. This point is still under study. We must remember that members of this group of organisms show also a variable pathogenic power, and that the host responds with a variable degree of susceptibility or immunity.

The other species of microorganisms noted in Table 3 were found too infrequently to be considered as more than incidental aids in presenting an individual picture of a stage in chronic conjunctivitis which might be considered clinically as trachoma in exacerbation. Thus there were several of these cases, notably the tetragenus and the yeast infections, that passed through a clinical course of conjunctivitis lasting several months, and were diagnosed for some time as papillary trachoma with follicles. These eyes finally became completely normal. They were all through most of their course mixed infections; one of the yeast cases had also the hemoglobinophilic bacilli, the other two yeast infections and the two tetragenus infections showed streptococci as well.

Anaerobic cultures.—When the cultural work began deep tubes of the different media used were inoculated and grown under albolene. We discovered the interesting fact that under these conditions both hemoglobinophilic bacilli and gonococci would grow in the depths of the tubes. When we found that no unidentified organisms grew in this way in a series of cases diagnosed then as trachoma and which contained trachoma inclusions, this method of growth was discontinued. That we may have missed important organisms by discontinuing this method is possible. We have not worked out all of the organisms found in the tubes of enriching media. We have diagnosed them from their morphology and staining characteristics as belonging to one or the other of the groups mentioned in Table 3. In a few cases of papillary conjunctivitis we have found a minute gram-negative bacillus which grew abundantly on all media. In a few other cases in the same condition, we found a minute gram-amphiole bacillus which we did not isolate. No doubt a number of cocci escaped us but none of these were frequent enough, either in the original plates or in the enriching media, to be considered of pathogenic importance.

In summing up this cultural work, we wish to emphasize the following points:

1. Hemoglobinophilic bacilli are present much more frequently than was thought in cases of chronic as well as of acute conjunctivitis.

2. These bacilli were obtained in abundant cultures from all cases examined that were diagnosed clinically as "pink eye" or acute contagious conjunctivitis. No classic Koch-Weeks bacillus was found; therefore the bacillus apparently producing "acute contagious conjunctivitis" in these cases is a strict hemoglobinophile.

3. None of the 424 strains of hemoglobinophilic bacilli isolated in this series can so far be differentiated from the influenza bacillus.

4. These bacilli are found in cases of papillary conjunctivitis ("acute trachoma") coincidently with trachoma (Prowazek) inclusions.

5. These bacilli in pure cultures present morphologically the same cycle of development as that shown by the trachoma inclusions seen in direct smears from cases of papillary conjunctivitis, and these direct smears also show transition forms between bacilli and inclusions. Therefore bacilli and inclusions are probably identical in these cases.

6. Among all of the species of microorganisms isolated from cases of conjunctivitis only the gonococcus shows in pure cultures a cycle of development similar to that of the hemoglobinophilic bacilli; but the fact that the former presents certain characteristics corresponding to the characteristics found in the trachoma

inclusions seen in direct smears from the host cases (gonorrheal ophthalmia neonatorum), coupled with the fact that transition forms between gonococci and inclusions are also seen in these smears, makes it probable that inclusions and gonococci are identical in *these cases*.

7. Trachoma inclusions, then, are simply intracellular nests of growing bacteria.

8. Among the other microorganisms found in these cases certain staphylococci and certain of the non-hemolyzing streptococci may play an important part in the chronicity of certain cases, especially in cases of pannus.

VI. DISCUSSION, SUMMARY, AND CONCLUSIONS.

ANNA WESSELS WILLIAMS.

DISCUSSION.

The chief practical questions this study calls forth are: (1) Does a specific disease called trachoma exist in New York City? (2) If it does exist, how many individuals does it affect? (3) How contagious is it?

While our study has corroborated the opinion of others that there is no clear-cut clinical entity called trachoma, it has not ruled out the possibility of there being a specific disease answering in part at least to the classic descriptions of trachoma.

In considering the question of the present existence of such a disease in New York City, we must bear in mind several facts: (1) Since 1897 no case diagnosed as "active trachoma" has been allowed to enter New York City through its port. Without doubt this has lessened in a marked degree fresh foci of eye infections. (2) The poor in New York City, among whom most of the cases diagnosed as trachoma occur, live on the whole more hygienically than they do in their native countries where trachoma is said to be frequent. (3) The methods of caring for the eyes of the citizens of New York City are becoming better year by year, through the employment of various agencies, such as school inspections and hygienic procedures, eye clinics, home visits, public lectures, and so on. The resulting conditions are directly preventive of the development of an infection from any case of "beginning trachoma" which either may have been infected from an "old case" or a "carrier" or may have slipped through the port, as it might readily do even with the port's strict oversight if the majority of cases begin insidiously, as most authors think.

Under these conditions, therefore, we may still be having many new cases of trachoma which either abort or run a comparatively mild atypical course to cure.

Our studies so far show either that this conclusion is correct or that at present we have practically no cases of trachoma among the public-school children on the lower East Side of New York City in a district supposed to be a hotbed of trachoma.

For among these 4,000 or more cases of conjunctival affections in the school children under observation for an average of 3 years and seen from or near the beginning of the disease, none have so far shown cicatricial formation except those among the few operated upon (expression) who show "operative scars." Moreover, the great majority of all of the cases, after passing through a comparatively short chronic course, have presented and still present apparently normal conjunctivas.

That our cases have been under exceptional hygienic and medical treatment from the beginning of the diseased conditions may account in great measure for this result. But whether they are cured light cases of trachoma, or simply quiescent cases of trachoma ready to show specific exacerbation under certain conditions; or whether they are cases which were infected only with germs other than a specific trachoma germ leaving their conjunctivas subject to reinfection and ready to progress, if later they become neglected, to "non-trachomatous pannus or cicatricial formation" or both, may be answered only by future study.

Among this large group of cases only eight during our period of observation have developed a condition diagnosed by ophthalmologists as pannus. Whether this condition in these cases is a specific manifestation of a trachoma virus, we cannot say. All of these cases but one have now practically clear corneas and normal conjunctivas. All of them had, antedating and accompanying the pannus, more or less papillary conjunctivitis and follicle formation. From all of the eight curetted conjunctivas members of the pneumo-streptococcus group were obtained. A polyvalent vaccine made from strains of the pneumo-streptococcus group seemed to have a quickening effect upon the march of these cases to recovery. Whether or not this was simply coincidence it is too soon to say.

Among our cases over 300 showed a sluggish papillary thickening of the conjunctiva accompanied in most cases by mucopurulent secretion and by marked follicle formation apparently through the depths of the conjunctiva. The occurrence in these cases of trachoma inclusions and hemoglobinophilic bacilli at the height of the affection and irregularly throughout the course, coupled with the morphologic similarity of bacilli and inclusions (see Plate 2), has led us to the hypothesis that hemoglobinophilic bacilli growing in nests in the epithelial cells of the conjunctiva are identical with trachoma inclusions in these cases and are the cause of these subacute and chronic cases (papillary conjunctivitis with or without follicles) as well as of acute conjunctivitis. Whether or not this hypothesis is correct, the results from its practical application—i. e., treating more minutely and following up all of our acute cases of conjunctivitis until we are sure of cure, as well as hunting up and treating acute cases in the families—give evidence that it works.

The fact that we found trachoma inclusions in 8 cases of acute catarrhal conjunctivitis, cured in an average of 8 weeks, while transition stages between bacilli and inclusions in these and other acute cases were frequently seen, lends more evidence to this hypothesis.

There is no question, from our studies, but that bacteria other than hemoglobinophilic bacilli may grow in nests in the epithelial cells of the conjunctiva and so produce appearances like trachoma inclusions, e.g., gonococci in cases of gonorrheal ophthalmia; and it is possible that we have missed a "specific trachoma bacterium" in some of our cases. But the evidence seems strongly in favor of the truth of our hypothesis at least as regards the great majority of the cases of conjunctivitis in our public school children.

Furthermore the evidence admits the possibility that neglected cases, or especially susceptible cases, infected with hemoglobinophilic bacilli may result in a fibrous tissue stage.

As regards the question of the degree of infectivity of these cases, again it is difficult to give a clear-cut answer, owing to the variableness of the clinical picture.

On the whole we have found that our schools at present seem to play an immaterial part in the spread of the chronic eye affections. Among more than 100,000 school children in the 60 schools we have studied more closely on the lower East Side, only about 3,000 have shown during the past 3 years more or less chronic affections of the conjunctiva and over 2,000 of these have been only mild folliculosis. As for the more serious cases, no school stands out particularly as a focus of infection. The few schools that have the most cases have children coming from the most unhygienic families. In isolated instances in the past, infections apparently contracted in the classroom have been reported, but none have come under our observation during the past 4 years. The possibility of the spread of eye infections in schools may be reduced to a minimum by the employment of proper hygienic precautions such as have been carried out in Public School 21, described in Dr. von Sholly's paper of this series.

In regard to home infection we have made estimates from two groups of cases. The first estimate (given in Miss Kurtz's paper) is made from the average chronic cases of papillary conjunctivitis. The percentage of probable infection was found to be 22.

In our other estimate made later, in which were included a number of the "old trachoma" cases, as well as cases of papillary conjunctivitis, Miss Gurley found that in 87 families with an average of 7.5 individuals to the family (653 individuals), 144 individuals had a condition diagnosed by most ophthalmologists as trachoma. Of these, 57, excluding the one in each family presumably infected from the outside, developed during the period of infection a chronic papillary conjunctivitis with follicles, that is, about 10 per cent of the 566 individuals exposed, a smaller proportion than that usually given. In the families of the 38 pannus cases we have had (most of them among the chronic adult cases) a remarkably low percentage of cases of chronic conjunctivitis developed in the exposed individuals.

That our campaign in behalf of personal hygiene, both in home and in school, carried on during the whole course of these studies helped lessen the spread of infection from these cases, especially in the families, we think probable, not only from observations of isolated cases, but because at present so few subacute and chronic cases seem to be developing in our lower East Side district, while they are still reported as prevalent in other crowded sections of the city.

Unless we are able to exercise strict supervision over the cases of acute conjunctivitis occurring in schools and homes, and to carry out the school and home instructions in personal hygiene, we are convinced that after a time we may have large numbers of well-developed chronic cases, a certain percentage of which may finally show pannus and cicatricial changes. In short, they may present the picture seen at present in the neglected cases among the Kentucky mountains and on some of our Indian reservations.

SUMMARY.

1. The written descriptions of trachoma do not agree as to a clinical or a pathologic entity.

2. Among the children of 60 public schools in the crowded lower East Side of New York City (supposed to be a hotbed of trachoma) during the past 4 years we have found no cases of conjunctival affections answering in their entirety to the classic descriptions of trachoma.

3. None of the 3,000 and more cases of *follicular* affections in these children have developed cicatricial changes due to infection; on the contrary the great majority of them now present normal conjunctivas. We attribute these results chiefly to the following measures.

a) The carrying out of preventive methods of treatment such as ophthalmia schools and school clinics, summer camps, mothers' demonstration classes, home instructions, and "follow-up" work.

b) More minute care of acute, as well as of chronic cases, including the specific treatment given chiefly at clinics and the follow-up work in the homes.

c) Non-operative procedures in a large number of cases formerly operated upon.

4. Hemoglobinophilic bacilli are found in a large proportion of the cases of chronic conjunctivitis (especially of the papillary type) as well as in those of acute catarrhal conjunctivitis (including clinically typical "pink eye").

5. These bacilli, tho they probably represent several different varieties, have not yet been differentiated from *B. influenzae*.

6. These bacilli are found coincidently with trachoma inclusions in a high percentage of the cases of subacute and chronic conjunctivitis when examined from the beginning.

7. These bacilli show morphologic and staining characteristics similar to those seen in trachoma inclusions; and transition forms between bacilli and inclusions are frequently seen in these cases.

8. In a few cases of acute catarrhal conjunctivitis, trachoma inclusions and transition forms have been found coincidently with hemoglobinophilic bacilli and in several other acute cases transition forms have been often found.

9. Many of the cases of chronic papillary conjunctivitis not actually followed from the beginning by us give a history of repeated acute attacks, and several cases beginning with us as acute contagious conjunctivitis passed into the chronic condition called papillary conjunctivitis.

10. Cell inclusions similar to the trachoma inclusions found in the papillary conjunctivitis cases are found in cases of gonorrheal ophthalmia neonatorum, cultures from which show only gonococci. These inclusions differ somewhat from those found in the papillary conjunctivitis cases, and transition forms between gonococci and inclusions are seen in smears from the former cases.

11. Members of the pneumo-streptococcus group are frequently found in chronic as well as in acute cases, especially in those cases showing pannus.

CONCLUSIONS.

1. Trachoma inclusions are nests of growing bacteria in epithelial cells—hemoglobinophilic bacilli in certain cases of papillary conjunctivitis, gonococci in certain cases of gonorrheal conjunc-

tivitis and possibly other bacteria in certain other cases of conjunctivitis.

2. Under minute hygienic and medicinal treatment, such as is outlined in some of the preceding articles, the great majority, if not all, of the cases of conjunctival affections of children may run a benign course resulting in normal conjunctivas.

3. Comparatively few, if any, cases of chronic conjunctivitis develop in individuals exposed, if the rules of general and personal hygiene are carried out.

4. If trachoma is present or should be introduced among our school children it may be controlled by methods which are within practical limits.

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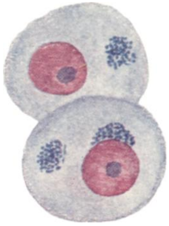
PLATE 2.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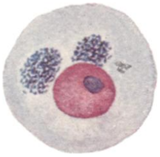
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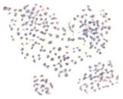
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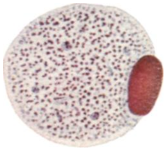
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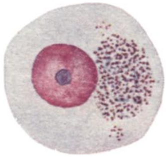
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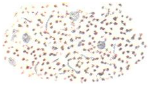
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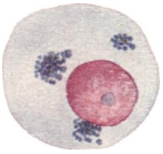
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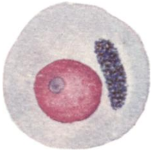
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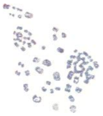
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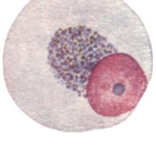
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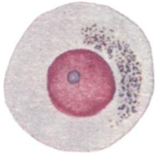
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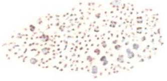
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EXPLANATION OF PLATE 2.[1]

FIGS. 1, 2, 4, and 5.—Epithelial cells containing trachoma inclusions in films taken from conjunctiva in case of papillary conjunctivitis (formerly diagnosed acute trachoma).

FIGS. 3 and 6.—Pure cultures of hemoglobinophilic bacilli from same case.

FIG. 1.—Initial forms of inclusions staining deep blue, some showing as small bacilli.

FIG. 2.—Later stage of inclusion showing beginning appearance of reddish granules.

FIG. 3.—Twenty-four-hour culture on blood agar of hemoglobinophilic bacilli showing coccoid forms similar in size and staining to those seen in early trachoma inclusions.

FIG. 4.—Later trachoma inclusions almost filling epithelial cell showing many reddish granules and irregularly shaped light blue bodies.

FIG. 5.—Another later stage showing beginning absorption (?) of the inclusions.

FIG. 6.—Four-day culture of the bacillus in Fig. 3, showing many reddish granules and irregularly shaped light blue masses similar in size and staining to those seen in later trachoma inclusions.

FIGS. 7, 8, 10, and 11.—Epithelial cells containing trachoma inclusions in film taken from conjunctiva in case of gonorrheal ophthalmia neonatorum.

FIGS. 9 and 12.—Pure cultures of gonococci from same case.

FIG. 7.—Early stage of inclusions showing morphologically typical cocci still at edge of inclusion.

FIG. 8.—Later stage of inclusion showing dense group and beginning minute reddish granules.

FIG. 9.—Twenty-four-hour cultures of gonococci on blood agar, showing staining and groups similar to those seen in epithelial cells in "early stage."

FIG. 10.—Later stage of inclusions from gonorrheal case, showing minute reddish granules.

FIG. 11.—Still later stage of inclusion showing irregular bluish bodies and scattered minute reddish granules.

FIG. 12.—Three-day pure culture of gonococci showing minute reddish granules and swollen bluish bodies similar to those seen in late inclusions.

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[1] All preparations stained by Giemsa and magnified about 1,200 diameters.